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SOME TYPOGRAPHICAL ERRORS IN VOLUME NINE OF THE AMERICAN MIDLAND NATURALIST

On page 283 of number seven the name of the family "Biddulphioideae" should be set in the same size type as "Discoideae," "Fragillarioideae," and other co-ordinate families.

The title, "The Native Flora of the Vicinity of Cold Spring Harbor, N. Y." should appear on page 384 of number nine.

The name of the author, N. M. Grier, should have been included in the title on page 513 of number 10. Also, on the same page, the division "Bacillariophyta" should have been separated from the title by more than a single space.

On page 524 is a subdivision of an article on the "Fossil Flora" entitled "Insect Galls." This should obviously not be placed here.

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Comandra Umbellata (L.) Nutt.

THEO. HOLM.

(With 12 figures drawn by the author.)

Six species are known of the genus *Comandra* Nutt.: *C. elegans* (Roch.) Rchb. fil. from central Europe, *C. umbellata* (L.) Nutt., *C. Richardsiana* Fernald, *C. pallida* A. D C., *C. californica* Eastw. ined., and *C. livida* Richards from North America. They represent two distinct sections, as already pointed out by W. I. Hooker, based upon the structure of the flower: "the whole tube of the calyx being incorporated with the germen" (*C. livida*) ; and: only the lower part of the tube being united with the ovary" (*C. umbellata* and the other species). Another distinction is pointed out by Bentham and Hooker viz., "fructu globoso maturo denudato, exocarpio succulento (*C. livida*), and: "fructu ovoideo parum carnoso perianthii reliquiis coronato (the others) ; the former section is called "*Haplocomandra,*" the latter "*Eucomandra.*" Regarding the habit they are suffrutescent and provided with a horizontally creeping rhizome, at least the American species; the rhizome of the European species is neither described nor figured by Reichenbach.

The floral structure is very complicated, and although Eichler, Bentham and Hooker have defined the floral envelope as a perianth, Gray and subsequent authors speak of a calyx; the peculiar structure of the rhizome has not been touched upon except "rootstock under-ground," and the anatomical structure is but imperfectly known. For this reason we have re-examined *C. umbellata,* which is frequent in our vicinity, and the following notes based upon fresh material, may be of some interest to students of plant-morphology. We regret,

however, that we have been unable to trace the life-history from the seedling-stage, and that we have never observed a single case, that would demonstrate the parasitic habit of the species in spite of its generally abundant occurrence. The geographical distribution extends from central Maine to Wisconsin and Georgia; it grows in sandy or gravelly soil, in open thickets, frequently associated with *Rhus quercifolia, Tephrosia virginiana, Epigaea,* etc.

THE VEGETATIVE REPRODUCTION.

The accompanying four drawings (Figs. 1-4) are small, but sufficient for illustrating the vegetative reproduction. Rhizomes measuring in length until 50 cm. are frequent, but they are not more instructive than the small ones figured. Characteristic of the rhizome is the horizontal growth, the scant development of roots with haustoria, the very irregular development of lateral, subterranean branches, and of aerial, erect, flower-bearing shoots; moreover the subterranean leaves are very small, scale-like, and membranaceous, of very short duration, and leaving no scars upon the rhizome. This in connection with the fact, that the whole rhizome is of a grayish-brown color with the surface very uneven from the numerous layers of cork renders the external structure more similar to a root with root-shoots than a stem.

Figure 1 thus shows a mature rhizome of which the terminal bud (B) is still dormant; behind the bud are four flower-bearing shoots (S) of which only the basal internodes have been figured. The very irregular development of the shoots is readily noticeable, buds and aerial shoots being mixed without any order. The short roots appear generally close to the buds. In figure 2 we have shown the horizontal, creeping apex of a rhizome with a terminal bud, and with several young, secondary roots. A similar structure was observed in some other rhizomes, but in these the terminal portion was ascending, and had developed into a flower-bearing shoot. The branches of the rhizome, which remain under-ground (Fig. 3), are relatively stout, and the leaves may be observed upon these during the fall. Then we have also a reproduction by means of buds developed in the axils of the basal leaves of the aerial

shoots (Fig. 4), and these buds will develop into aerial shoots next year, floral as well as purely vegetative; as many as five flower-bearing shoots may be found developed from the base of a single stem of the year preceding. The vegetative reproduction is thus very highly exemplified in this species, presumably at the expense of the floral reproduction, since the number of fruits developed is remarkably small in proportion to the abundance of the flowers. Corresponding cases are known from several other plants, for instance from *Apocynum, Asclepias* and *Acerates,* where constantly only one or two fruits are developed in the rich-flowered inflorescence; but in these the vegetative reproduction is confined to the root-system, developing root-shoots in abundance, while these plants are totally destitute of rhizomes in the stricter sense of the word.

THE INFLORESCENCE AND THE FLOWER.

According to Eichler the inflorescence of the *Santalaceae* is principally botrytic (raceme, spike or capitulum) since the prophylla, when altogether present, are mostly without axillary flowers; but when the prophylla are fertile, the single, lateral axes may become changed to cymes of the dichasial type as is the case in *Comandra* and several species of *Thesium.* In *Comandra umbellata* the upper stem-leaves subtend two to three-flowered cymes, and the prophylla are small, but green; in the two-flowered cymes the median has aborted. Sometimes we may find an inflorescence with the axillary branches bearing secondary cymes, and the accompanying diagram illustrates a case of that kind; the central flower is not developed. This inflorescence is borne upon a distinct peduncle (about 10 cm. long), and, as shown in the figure, (Fig. 6) there are two pairs of large, opposite bracts (L^1 and L^2), L^1 being the larger. The apical flower is aborted, but in the axil of the two smaller bracts (L^2) a single flower is developed, none of which are provided with prophylla. Finally in the axils of the two larger bracts (L^1) a secondary three-flowered cyme is developed, borne upon a distinct peduncle, and overtopping the central flowers. These secondary cymes begin with a pair of prophylla (P), situated to the right and left of the central flower, and

each subtending a flower. This inflorescence, exceptional as it be, thus shows, that a regular cyme with bracts may occur in *Comandra umbellata*, and that the development of the bracts may, to some extent, result in the suppression of the prophylla of the central system of flowers.

Now with respect to the flower, this is typically pentamerous in Comandra, but tetramerous flowers occur also, as shown in the two flowers, drawn in the diagram (Fig. 6). In such tetramerous flowers the perianth-leaves and the stamens form a cross diagonally with the axis. It is not uncommon in *Comandra umbellata* that the inflorescences are only two-flowered, but the pentamerous structure is always the most frequent, and the typical of the genus.

The morphological interpretation of the floral organs in the *Santalaceae* has been discussed very extensively, and the opinions expressed are at great variance. Eichler gives the history of this subject, and the difficulty depends on defining the floral leaves as representing a calyx, a corolla or simply a perianth, in which the petals are undeveloped. While many authors have expressed the opinion, that the flower has only a calyx, Alph. De Candolle and Baillon considered the flower as being asepalous; Eichler, on the other hand, prefers to define the floral envelope as simply a perianth. Regarding the definition of the floral leaves representing a calyx, this is only based upon the fact that the stamens are always opposite the perianth-leaves; we must remember, however, that in none of the genera of the family does there exist a single case, where an inner whorl of leaves is present, alternating with the stamens. The view expressed by De Candolle, that the calyx has aborted, seems more justified, because the position of the perianth-leaves being 2-3, besides that the frequent diagonal crossing agrees better with a corolla than with a calyx; furthermore as demonstrated by Baillon the segments of the perianth are developed simultaneously. De Candolle believed also that the small denticulations in the flower of *Choretrum* indicated traces of a calyx, and he compared these with the plainly developed foliar organs in the pistillate flower of *Buckleya* "ad demonstrationem natum genus." An analogous instance is cited by Baillon from *Lavallea*, but this genus has

since been referred to the *Olacineae* by Bentham and Hooker, and according to Eichler's opinion *Buckleya*, which De Candolle raised to a tribe of its own, ought also be placed in this family, *Olacineae*. And with regard to the denticulations in *Choretrum*, Eichler considers it a question, whether these really are rudimentary leaves or whether they merely represent processes of the superior margin of the ovary. Similar formations are known also from the *Loranthaceae*, where they are called "calycodium" as suggested by Planchon and Decaisne. The simultaneous development of the perianth-leaves is according to Eichler no proof of their morphological identity being a corolla, because such is also the case of the non-ambiguous calyx of *Stellatae*, *Valerianeae*, *etc.;* with respect to the position being 2-3 in the pentamerous flowers, as pointed out by De Candolle, this same position occurs also in the calyx of *Lobeliaceae*, *Rhodoraceae*, *Popilionaceae*, etc. Taking these various points into consideration Eichler prefers to designate the floral envelope neither as a calyx nor a corolla, but as a simple perianth, characteristic of which is the simultaneous development of the leaves, and the frequent diagonal position of these to the axis in the tetramerous flowers.

Finally with respect to the position of the stamens being opposite to the perianth-leaves, a structure, which recurs in the *Loranthaceae*, Hofmeister and Van Tieghem considered stamen and perianth-leaf to represent a simple phyllom. The latter author, who studied the anatomical structure of the flower of the *Santalaceae*, observed only one mestome-strand in this organ, and reached the conclusion: "L'étamine y est une dependance vasculaire de la face interne du sépale." According to Eichler stamen and leaf represent two organs, which have grown together; as a matter of fact both organs may be observed as almost separate in various species of *Viscum*, etc., besides that flowers with three perianth-leaves and with only two stamens may be found occasionally, in which one of the stamens is situated between two of the perianth leaves. The morphological construction of the flowers of the *Santalaceae* as well as the inflorescence, and the vegetative reproduction offer many points of interest, still, renewed inves-

tigations and observations on fresh material would undoubtedly add numerous others.

INTERNAL STRUCTURE OF THE VEGETATIVE ORGANS.

The Roots.—As mentioned above the roots are short, sparingly branched, and provided with haustoria; they remain active for more than one year, but increase very little in thickness. The increase is effected by the pericambium developing cork and secondary cortex, thus the epidermis and the primary cortex become partly thrown off, or collapse. The primary cortex is thinwalled, homogeneous, and contains no deposits of starch. The cork represents a broad zone, thinwalled throughout, and surrounds a secondary cortex, rich in starch, and containing two small strands of stereome, located outside the two primary strands of leptome. The stele represents an almost regular, quadrangular (in cross-sections) group of hadrome with four short rays of vessels and with thickwalled conjunctive tissue extending to the center of the stele. The leptome represents four very distinct strands, but only the two of them are supported by stereome. There are several strata of cambium visible between the leptome and hadrome, thus the increase within the stele itself is more slowly advancing than in the peripheral tissues, the secondary cortex and the cork, which have almost attained their final development.

The Rhizome.—The young stolon drawn in figure 3 (St.) shows the structure as follows. The outer cell-wall of epidermis is thick, and covered with a thin, smooth cuticle; the cortex is homogeneous, and consists of c. 14 compact strata of thinwalled parenchyma without deposits of starch or crystals. There is no endodermis, and no distinct, continuous pericycle either, but a band of isolated strands of stereome (St. in figs. 7 and 8) of a few, two or three strata. Inside this band of stereids a meristematic tissue forms a closed, continuous band giving rise to a beginning formation of cork towards the periphery, while inwards a broad zone of thinwalled, compact parenchyma has become developed, a secondary cortex of 15-20 layers, rich in starch, and in the periphery of which secondary

strands of stereome are developed, corresponding with the primary, but yet very thinwalled (St.* in Fig. 7 and 8); these secondary strands of stereome extend through the secondary cortex to the leptome, as very narrow rays, the stereids themselves being more or less compressed radially. Bsides these strands, which are situated in the same radii as the primary stereome there are also some very young strands visible between these (St.* in Figure 8) which thus indicate the final development of a larger number of stereomatic rays from the leptome towards the phellogen. Regarding the stele in the stolon the hadromatic rays are relatively short with no indication of libriform (Fig. 9). The pith represents a broad parenchyma of thinwalled cells with a little starch in small grains.

While thus the peripheral tissues from the epidermis to the cork are well preserved in the young stolon, we notice in the older rhizome only the cork as a broad zone, and thinwalled as before. The secondary stereome now represents many radiating strands, and is very thick-walled. The secondary cortex shows the same structure as before, but contains also some aggregated crystals of calcium-oxalate. The mestome represents a compact stele with deep rays of hadrome with wide vessels and much thickwalled libriform; in the center of the stele is a compact, thinwalled pith with a little starch of small grains.

The Aerial Stem.—From base to apex we find the same tissues, and arranged in exactly the same manner as in the subterranean rhizome, with the difference, however, that the secondary tissues are absent, of course, from the stem-part, which does not last for more than one season; the species being suffrutescent only the basal internodes persist and remain active for several years. In beginning with the basal internodes, the peripheral tissues are intact although increase in thickness has taken place, resulting in the development of cork, secondary stereome, and secondary cortex. The cuticle is thick, smooth, and the outer cell-wall of the epidermis is very thick; the cortex consists of c. 8 strata of thinwalled cells, containing cholorophyll, but no crystals; it is somewhat collapsed here and there on account of the increase in thickness of the inner tissues. Fourteen separate strands of thick-

walled stereome form a band, surrounding a broad zone of thinwalled cork; then follows a broad parenchyma, the secondary cortex, containing large, aggregated crystals besides deposits of starch, and in the periphery of this parenchyma we notice small stereomatic strands in the same radii as the former, the primary stereome. With respect to the stele the hadrome forms deep rays, and thick-walled libriform is well represented. The central portion of the stele is represented by a broad pith, thinwalled, but solid, and containing starch of fine grains in the peripheral layers, but no crystals.

A more simple structure characterizes the upper internodes, in which no increase in thickness takes place. The surface of these internodes is not smooth as is the case of the basal, but shows longitudinal crests, very low, but well marked, and these correspond with the stereomatic strands in the cortex. The cuticle and the epidermis show the same structure as in the basal internodes; the cortex consists of c. 6 chlorophyll-bearing layers between the strands of stereome, and of only two outside these. The number of stereomatic strands is fourteen, and they are located just outside the fourteen collateral mestome-strands, which constitute the stele, and of which the hadrome shows many wide vessels, and much thick-walled libriform; the hadrome is in the form of the letter V (in cross-sections) with the point extending deeply into the pith. Between these primary mestome-strands the interfascicular cambium has given rise to small strands of leptome and a few vessels. The pith shows the same structure as in the basal internodes, but contains no starch. So far as concerns the endodermis and the pericycle, none of these tissues were observed in these internodes, the latter at least nowhere as a closed sheath.

Characteristic of the stem-structure, the subterranean as well as the aerial, of *Comandra umbellata* is thus: the deep location of the phellogen i. e. inside the primary stereome-strands; the development of secondary stereome corresponding with the primary, and the constantly identical structure of all the internodes of the rhizome, its branches, the basal internodes of the aerial stems, in short of all the persisting parts

of the stem, recurring in the superior internodes with the only exclusion of the secondary tissues.

The Leaf.—The leaves are held in an erect position, and so far as concerns the chlorenchyma, the structure is approximately centric. The cuticle is thin, and smooth, and the epidermis shows the outer wall slightly thickened on both faces of the blade; viewed in superficial sections the lateral cell-walls are straight, nowhere undulate; the stomata are surrounded by four ordinary epidermal cells, and they are confined to the dorsal face of the leaf-blade; no hairs were observed. The chlorenchyma represents an almost homogeneous chlorophyll-bearing tissue of more or less isodiametrical cells, interspersed here and there with some few, short palisade-cells; no part of the chlorenchyma shows the structure characteristic of a pneumatic tissue. The midrib contains a single mestome-strand, with a large group of thinwalled stereome on the leptome-side, and embedded in a small water-storage tissue, becoming slightly collenchymatic in the keel; the lateral veins are embedded in the chlorenchyma, and lack stereome and water-storage tissue; they are terminated by thickwalled, porose tracheids, generally in groups of two to five cells, the function of which is to store water. In some of the other genera, *Thesium*, *Quinchamalium* and *Myzodendron*, similar systems of tracheids occur, but these are totally independent of the mestome-strands of the veins; they traverse the chlorenchyma in various directions, and are especially characteristic of *Santalaceae*, *Loranthaceae*, *Loasaceae* and *Olacineae*.

According to Solereder the development of cork is always superficial in the *Santalaceae*, but as shown in the preceding pages, *Comandra umbellata* forms an exception; furthermore, when the development of secondarry stereome is only recorded from *Santalum* and *Omphacomeria*, we have seen that this occurs also in *Comandra*. The statements by Solereder are based upon Behm's treatment of the anatomy of *Santalaceae*, and this author describes *Comandra* as destitute of stereome, and makes no mention of the cork. Several other points differ from our observations, and it seems safe to conclude, that the material examined by Behm was not correctly identified.

Moreover Chatin has, many years ago, demonstrated the presence of primary stereome in *Comandra livida.*

In bringing these facts together we have in *Comandra umbellata* a remarkable type of a "terrestrial parasite," as the genus is always described to represent. But, when we consider the habit and structure of the mature plant, it would hardly seem probable that such old specimens are parasitic. The development of a large rhizome, and the profuse vegetative reproduction, altogether, does not point towards a parasitic habit, even if some of the roots are provided with haustoria. It seems more likely, we believe, that *Commandra* is only parasitic at the young stages of its development, and perhaps only in the first year, when a seedling, as is the case of so many of the herbaceous, terrestrial and green parasites of some of the other families, and notably the *Scrophulariaceae.*

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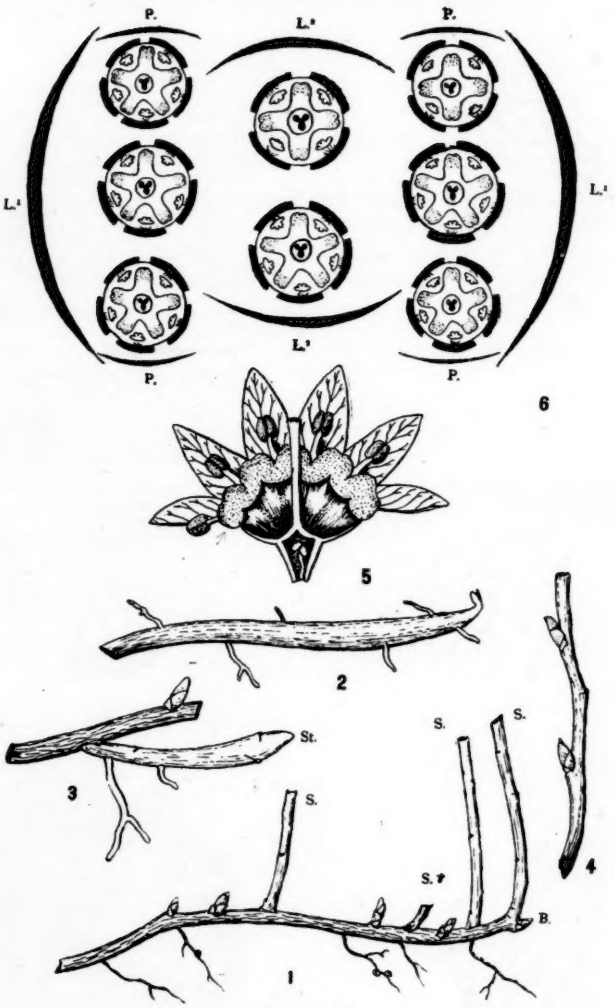
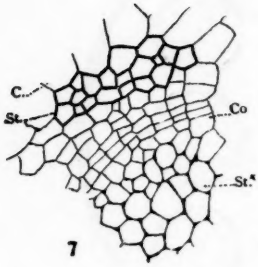


PLATE I.

EXPLANATION OF FIGURES.

Comandra umbellata.



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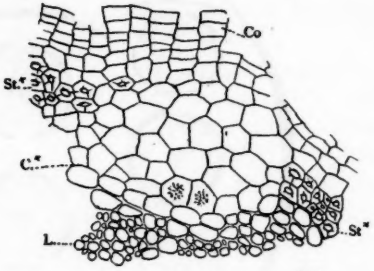

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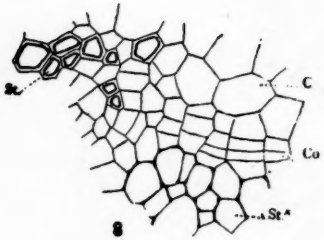

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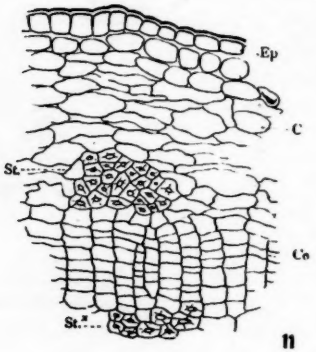

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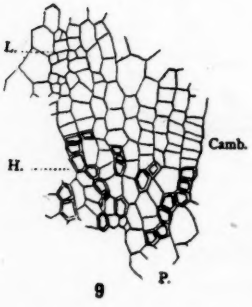

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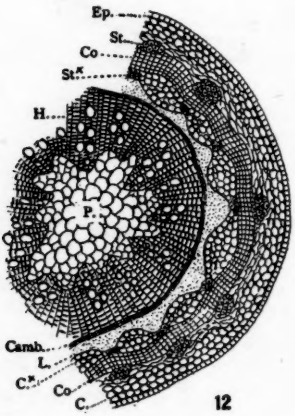

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PLATE II.

Figure 1. A mature rhizome, collected in September, 1923. B—the terminal bud; S—three flowering shoots of 1923; S*—base of a withered shoot of 1922; natural size.

Figure 2. Apex of a rhizome with the terminal bud, collected in June, 1923; 1 2-3 x natural size.

Figure 3. Part of a rhizome with a subterranean branch St., and a bud, which will develop an aerial shoot next year; 1 2-3 x natural size.

Figure 4. A basal internode of an aerial shoot with buds to winter over; collected in September; 1 2-3 x natural size.

Figure 5. A flower, laid open; enlarged.

Figure 6. Diagram of an inflorescence; L^1 and L^2 the bracts; P—the prophylla; for explanation see the text.

Figure 7. Cross-section of a young stolon, collected in October; C—primary cortex; St.—primary stereome; Co.—cork; St.*—secondary, young stereome; x 240.

Figure 8. Cross-section of the young stolon, showing a strand of secondary young stereome (St.*) between two strands of primary stereome (St.), of which only one has been drawn; Co.—cork; x 320.

Figure 9. Cross-section of a mestome-strand from the stolon; L—leptome; Camb.—cambium; H—hadrome; P—pith; x 320.

Figure 10. Cross-section of a basal internode of a flower-bearing stem; C*—secondary cortex; the other letters as above; x 320.

Figure 11. Cross-section of same internode; Ep.—epidermis; C.—primary cortex; other letters as above; x320.

Figure 12.—Cross-section of same internode, showing the arrangement of all the tissues from the epidermis to the central pith; letters as above; x 60.

Clinton, Md., November, 1923.

Some Effects of the First Fall Freeze.

O. A. STEVENS.

A tabulation of the degree to which different species of plants are injured by the first freezing temperature of autumn has seemed of interest. The past year was quite favorable to such observations, the first frost of the season on September 13 being accompanied by a minimum temperature of 27 degrees F. (Weather Bureau station at Moorhead, Minnesota.) Most of these observations were made two days later at Fargo, North Dakota. The following symbols are used to designate the condition of the plants. Those unmarked appeared to be uninjured:

1. Slightly injured; a few leaves killed.
2. About half of the leaves killed.
3. Entirely killed.
* In flower.
** Flowering after the freeze.

Many of the plants named would not be expected to show injury but the list will show the extent of the observations. Some common cultivated plants indicate the severity of the freeze. Sweet corn, tomato, cucurbits, zinnia, cosmos, entirely killed; beet, cauliflower, leaves partly killed; celery, parsnip, carrot, cabbage, sweet pea, uninjured.

Sagittaria arifolia	2-3	Salomonia commutata	
Digitaria humifusa	3	Smilax herbacea	
Panicum capillare	2	Juglans nigra (introduced)	3
Echinochloa crusgalli	3	Celtis occidentalis (small trees)	
Chaetochloa viridis	3	Urtica gracilis	
Homalocenchrus oryzoides		Urticastrum divaricatum	
Poa pratensis			3 (or nearly)
Bromus inermis		Rumex salicifolius	
Agropyron repens		Rumex persicarioides	
Hordeum jubatum		*Polygonum aviculare	
Elymus virginicus		*Polygonum erectum	
Cyperus esculentus	2	Polygonum lapathifolium	2
Arisaema triphyllum	3	Polygonum pennsylvanicum	2
Vagnera stellata		Polygonum emersum	

Polygonum convolvulus	2-3	**Malva borealis	
*Chenopodium album	2-3	Viola pubescens	
Chenopodium hybridum	1	*Viola rugulosa	
Atriplex patula		Washingtonia longistylis	
Amaranthus retroflexus	3	Zizia aurea	
Amaranthus graecizans	3	Deringia canadensis	
Amaranthus blitoides	3	Heracleum lanatum	
**Alsine media		Cornus femina	
Silene noctiflora.		Steironema ciliatum	
Portulaca oleracea	2-3	Fraxinus lanceolata (small trees)	2-3
Ranunculus abortivus		Apocynum hypericifolium	
**Oxygraphis cymbalaria		Asclepias syriaca	3
Thalictrum dasycarpum		*Cuscuta gronovii	3
Anemone canadensis		Convolvulus sepium	3
Clematis virginiana		Hydrophyllum virginicum	
Menispermum canadense		Physostegia parviflora	
**Thlaspi arvense		*Stachys palustris	
*Lepidium apetalum		*Mentha canadensis	
**Bursa bursa-pastoris		Catalpa speciosa (introduced)	2
**Brassica arvensis		Plantago major	
*Sisymbrium altissimum	1	Plantago rugelii	
**Erucastrum pollichii		Galium triflorum (?) (seedlings)	
**Erysimum chieranthoides		Symphoricarpos occidentalis	
Radicula palustris		Micrampelis lobata (see notes)	
Ribes americanum		Ambrosia trifida	1-2
Ribes gracile		Ambrosia artemisiaefolia	
Rubus strigosus		Iva xanthiifolia	
Agrimonia striata		Xanthium canadense	1-2
Rosa arkansana		**Grindelia squarrosa	
Prunus virginiana		Solidago canadensis	
Trifolium pratense	1	Solidago serotina	
*Trifolium repens		Boltonia asteroides	
**Melilotus alba		**Aster laevis	
**Melilotus officinalis		*Aster paniculatus	
Medicago sativa	1	**Aster multiflorus	
Glycyrrhiza lepidota		**Leptilon canadense	1
Falcata comosa	2	*Rudbeckia lacinata	
**Oxalis stricta		Solidago serotina	
Euphorbia esula		Helianthus maximiliani	
Euphorbia serpyllifolia	2-3	Helianthus tuberosus	
Rhus radicans		*Bidens frondosa	
Acer negundo (small trees)	1-2	*Bidens acuta	
Vitis vulpina	2	*Bidens cernua	
Parthenocissus quinquefolia	2	*Artemisia biennis	
Tilia americana (small trees)		*Artemisia caudata	
Hibiscus trionum	3		

*Artemisia gnaphalodes		*Sonchus oleraceus	2
Artemisia frigida		*Sonchus asper	2
Arctium minor		*Lactuca scariola	3
Carduus undulatus		Lactuca ludoviciana	3?
Carduus arvensis		*Lactuca spicata	
**Taraxacum officinale		Lactuca pulchella	
*Sonchus arvensis	2		

About half of the species were noted in the open, the others in the woods and along the riverbank. Some differences were observed in the plants of the same species growing under different conditions, but it has seemed hardly worth while to keep the two lists separate. At one place in the woods Urticastrum, Falcata and Hydrophyllum were noted growing close together and showing distinctly the 3, 2 and 0 conditions of injury. At another place the Urticastrum was not entirely killed although better protection was not evident. A branch of Micrampelis running across a narrow bar by the river's edge seemed quite untouched, but plants on bushes in a low place between a bank and the other edge of the woods were entirely killed. Echinochloa and Panicum capillare on the bar were killed.

In general, basal leaves were little affected even where stem leaves were entirely killed. Sonchus spp. showed such a condition. Lactuca scariola was entirely killed as to leafy stems, but the leaves of seedlings remanied fresh and green. Occasional plants of Sonchus oleraceus and S. asper were observed in flower among houses of the city some time after the frost. One plant of Lactuca scariola was observed thus, but it may not have flowered previous to the frost. A few fresh plants of Chaetochloa viridis also were seen in such a position. Some species, notably Chenopodium album, appeared little affected on the date that the notes were taken, but a little later unprotected plants were observed to be mostly dead.

In addition to Thlaspi, Alsine, Taraxacum and Brassica, Malva borealis was one of the notably hardy plants, growing vigorously and continuing to flower. After several other light freezes, temperatures of 13 degrees and 14 degrees occurred at the end of October. Following this most of the leaves of Taraxacum, Brassica, Melilotus, and Malva were dead. Small

plants of Thlaspi, some Alsine and the winter annual rosettes of Lactuca scariola were still quite fresh and green. Half or more of the leaves were killed on parsnips, celery and red clover.

The plants in the list may be divided into several groups as follows:

1. Introduced plants continuing to flower until frost—Chaetochloa, Digitaria, Panicum capillare, Echinochloa, Amaranthus, Polygonum spp., Hibiscus, Lactuca scariola, Sonchus.
2. Tender natives—Sagittaria, Arisaema, Asclepias, Cuscuta, Convolvulus.
3. Partly tender natives—Falcata, Euphorbia, Acer negundo, Vitis, Parthenocissus, Fraxinus, Micrampelis, Ambrosia trifida, Xanthium.
4. Plants which have completed flowering and growth; leaves apparently little injured, but leaf fall probably hastened by frost—Vagnera, Salomonia, Smilax, Rumex, Clematis and many others.
5. Plants which have flowered earlier but retain more or less hardy basal foliage—Ranunculus abortivus, Anemone canadensis, Viola, Washingtonia, etc.
6. Late flowering, hardy plants—Solidago, Aster, etc.
7. Hardy plants flowering throughout season, and frequently after frost—Alsine, Oxygraphis, Cruciferae, Melilotus, Oxalis, Malva, Taraxacum.
8. Winter annuals and biennials (seedlings)—Cruciferae, Arctium, Lactuca scariola, Artemisia caudata.

North Dakota Agricultural College.

The Naiad-Fauna of Duck River in Tennessee.

BY DR. A. E. ORTMANN.

Duck River in central Tennessee is one of the most important tributaries of the Tennessee River. It has the peculiarity of running in an east-westerly direction, and joining the Tennessee in that part of its course, which is directed across the state from South to North, while other tributaries of this region run essentially in a southerly or southwesterly direction, flowing into Alabama and uniting with the master stream at, and for some distance above, the Mussel Shoals.

The sources of Duck River are in the part of the Cumberland Plateau (in its widest sense), called the *Highland Rim*, at an elevation of about 1200 feet (see U. S. Topogr. Atlas sheet Hollow Springs), that is to say rather low as compared with other streams of this region. The Highland Rim consists largely of Lower Carboniferous siliceous limestones (Mississippian). Flowing then, in the main, in a direction somewhat north of west, it traverses in a valley of entrenched meanders the *Nashville Dome* (or the interior basin of Central Tennessee), consisting of Middle and Upper Ordovician rocks, reaching, between Columbia and Centreville, again the Mississippian Highland Rim of the western flank of the dome, and continuing in it to its junction with the Tennessee.

The greatest part of its drainage is in this central basin, only *Buffalo River*, its largest tributary, is entirely in the western portion of the Highland Rim. I visited the latter only on its headwaters. Of other tributaries, I am acquainted with *Big Bigby Creek* and *Rutherford Creek* in Maury Co.; with *Rock Creek* in Marshall Co.; *Garrison Creek* and *Thompson Creek* in Bedford Co. (all these in the interior basin); and *Little Duck River*, Coffee Co. (eastern part of Highland Rim); but I found Naiades only in *Buffalo River* and *Garrison Creek*.

In the main river, however, Naiades are abundant, and I collected at eleven stations, from Centreville to Manchester,

mostly with great success. Duck River is in very good condition, no pollution entering it, except in the region between Columbia and Centreville, where Phosphate mines send muddy water to it; but the amount of pollution is small, and its character obscure, and only at Centreville some indication of an injurious effect was noticed. For the rest, Naiad-life was plentiful, the gravel bars were covered with large numbers of dead shells, and the living ones were found at the proper places in abundance, often closely crowded together. Of course, towards the headwaters, the number of species and individuals decreases, and at Manchester there was only one species in small numbers.

Duck River being located between Cumberland River in Kentucky and Tennessee, and Tennessee River in northern Alabama, might be expected to contain a similar fauna to these two systems, a fauna which is known to contain peculiar elements, not found outside of this region in the Central Basin (Mississippi and Ohio drainages), which might be called "Cumberlandian" types (from the "Cumberland subregion").* And indeed, some of them are present. But I have found that there are other constituents in this fauna, and in view of our poor knowledge of the Naiad-fauna of the Cumberland subregion, chiefly of the exact distributional facts of the various forms, I thought it might be desirable, to connect the present study with an investigation of the zoögeographical affinities of Duck River. The material thus presented will be useful for a subsequent general study of the history of the Cumberland Naiad-fauna, the fauna of the Cumberland and Tennessee Rivers. †

Our previous knowledge of the Naiades of Duck River is very unsatisfactory. Lea, in his publications collected in "Observations on the Genus Unio," mentions four species: *U. big-*

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* More about these will be found toward the end of this paper.

† The principal papers published more recently, which treat of this fauna, and are largely cited in the following pages, are the following: Wilson, C. B. and Clark, H. W. The Mussels of the Cumberland River and its Tributaries (Bur. of Fisher. Doc. 781. 1914. 63 pp.). Ortmann, A. E. The Naiades of the Upper Tennessee Drainage, Etc. (Proc. Amer. Philos. Soc. 57. 1918. pp. 521-626).

byensis Lea '41 (Obs. 3. '42) from Big Bigby Creek, Maury Co.; *U. clarkianus* Lea '52 (Obs. 5, '52) from Williamsport, Maury Co.; *U. cylindrellus* Lea '68 (Obs. 12, '69); and *U. validus* Lea '71 (Obs. 13, '74), both from "Duck River, Tenn." Of these, *U. clarkianus* (Lampsilis clarkiana) should be canceled (already questioned by Simpson), the locality apparently being erroneous, this shell belonging to the headwaters of the Alabama drainage. The other three species stand now as *Fusconaia barnesiana bigbyensis, Carnuculina cylindrella,* and *Fusconala barnesiana,* their presence in Duck River being confirmed by my observations.

In 1885, Hinkley and Marsh * published a list of Naiades from central Tennessee. Unfortunately, the identifications are not all reliable, and in several cases it remains doubtful, which species were intended. A number of these shells came from Duck River at Columbia, Maury Co., Tenn., and it has been possible to recognize many of them according to my own collections made at Columbia and in Duck River in general. They are the following, arranged according to the modern system and the modern nomenclature:

1. *Fusconaia barnesiana* (as *U. barnesianus* and *validus*)
2. *Megalonaias gigantea* (as *multiplicatus*)
3. *Amblema costata* (as *undulatus*)
4. *Quadrula pustulosa*
5. *Quadrula fragosa*
6. *Quadrula verrucosa* (as *tuberculatus*)
7. *Quadrula intermedia*
8. *Quadrula cylindrica*
9. *Cyclonaias tuberculata* (as *verrucosus*)
10. *Lexingtonia doiabelloides* (as *circumactus*)
11. *Pleurobema cordatum pyramidatum*
12. *Pleurobema oviforme* (as *clinchensis, lesleyi patulus*)
13. *Pleurobema oviforme holstonense* (as *pattinoides*).
14. *Eiliptio crassidens* (as *gibber*)
15. *Eiliptio dilatatus* (as *gibbosus*)
16. *Lastena lata* (as *dehiscens*)
17. *Lasmigona costata* (as *rugosa*)
18. *Strophitus rugosus* (as *schafferiana*)

* Hinkley, A. A. and Marsh, P. List of Shells Collected in Central Tennessee (Aledo, Ill. July, 1885). This paper has been overlooked by Simpson in the bibliography published in his "Synopsis" (1900). My attention has been called to it by C. Goodrich, Toledo, who also kindly loaned me his copy of it.

19. *Ptychobranchus fasciolare* (as *camelus*)
20. *Ptychobranchus subtentum*
21. *Obliquaria reflexa* (as *cornutus*)
22. *Cyprogenia irrorata*
23. *Obovaria retusa*
24. *Obovaria subrotunda* (as *circulus*)
25. *Actionaias pectorosa* (as *perdix*)
26. *Plagiola lineolata* (as *securis*)
27. *Truncilla truncata* (as *elegans*)
28. *Truncilla donaciformis*
29. *Leptodea leptodon* (as *tenuissimus*)
30. *Leptodea fragilis* (as *gracilis*)
31. *Carunculina cylindrella*
32. *Conradilla caelata*
33. *Medionidus conradicus*
34. *Micromya fabalis*
35. *Ligumia recta latissima* (as *rectus*)
36. *Lampsilis ovata*
37. *Lampsilis fasciola* (as *perradiatus*)
38. *Dysnomia triquetra* (as *triangularis*)
39. *Dysnomia brevidens*
40. *Dysnomia lenior*
41. *Dysnomia turgidula* (as *deviatus* and *turgidulus*)
42. *Dysnomia florentina*

In addition the following are in the list, but probably misidentified:

U. hartmanianus Lea. (*Pleurobema h.*) A Coosa River form, surely not present in Duck River. But it is impossible to say, what it stands for.

U. phillipsi Conrad. A species altogether doubtful; it may be an abnormal *Obliquaria reflexa.*

U. nashvillensis Lea. This is *Ligumia subrostrata,* a species very likely not found in Duck River, since the required ecological conditions are missing. It is possible that gigantic specimens of *Micromya vanuxemensis* (such as found by myself) have been taken for it.

Of the above 42 species I have been able to confirm the existence, in Duck River, of all except the following (7): *Elliptio crassidens, Cyprogenia irrorata, Obovaria retusa, Plagiola lineolata, Leptodea leptodon, Ligumia recta latissima. Dysnomia lenior.* Since they are all rather striking forms, not easily to be mistaken, they should be credited to Duck River, and will be enumerated below.

Three of the species given by Hinkley and Marsh are given also by Call * for Duck River: *U. clinchensis* (equals) *Pleurobema oviforme; U. multiradiatus* (equals) *U. perradiatus* (of Hinkley & Marsh) (equals) *Lapsilis fasciola;* and *U. turgidu-*

* Call, R. E. Geographical Catalogue of the Unionidae of the Mississippi Valley (Bull. Des Moines Acad. Sci. 1. 1885, pp. 1-57.)

lus (equals) *Dysnomia turg.;* and in subsequent paper*) he adds another one: *U. clavus*, but as will be shown below this is not the real *Pieurobema clava* (Lamarck), but should also be placed with *Pleurobema oviforme* (Conrad).

In the same year (1895), Marshall † gave incidentally a number of records for shells from Duck River (all connected with the name of Hinkley). There are 8 of them: *U. crassidens* (now: *Elliptio cr.*); *U. elegans* (now: *Truncilla truncata*); *U. fabalis,* (now: *Micromya f.*); *M. marginata* (now *Alasmidonta m.*); *U. multiradiatus* (now: *Lampsilis fasciola*); *M. rugosa* (now: *Lasmigona costata*); *U. triangularis* (now: *Dysnomia triquetra*); *U. undulatus* (now: *Amblema costata*). All are found in the list of Hinkley and Marsh, with exception of *Alasmidonta marginata.* It is interesting, that here *Elliptio crassidens* is given by its correct specific name (not as *gibber*).

Among older material, represented in the Carnegie Museum, the following forms from Duck River are found:

Megalonaias gigantea. Duck R. (Sterki collection).
Cyclonaias tuberculata, Duck R. (Sterki collection.)
Pleurobema cordatum catillus, Columbia. (Walker don.)
Pleurobema cordatum catillus, Columbia. (Walker don.).
Actinonaias pectorosa. Duck R. and Columbia (Hartman collection and Walker don.).
Conradilla caelata, Hickman Co. (Hartman collection.)
Dysnomia triquetra, Columbia (Clapp don.).
Dysnomia florentina walkeri, Duck R. (Sterki collection.)
Dysnomia capsaeformis. Columbia (Sterki collection).

Of these, *Pleurobema cordatum* and *cord. catillus,* and *Dysnomia capsaeformis* are new for this system, while *Dysnomia florentina walkeri* undoubtedly corresponds to *D. florentina*

I visited the river in 1921, 1922, and 1923, and obtained altogether 11 stations for Naiades in the main river, and two

* Call. R. E. A Study of the Unionidae of Arkansas, etc. Trans. Acad. St. Louis 7. 1895, pp. 1-64).

† Marshall, W. B. Geographical Distribution of the New York Unionidae (48. Ann. Rep. N. Y. State Mus. (1894) 1895, pp. 47-99).

(in the list of Hinkley and Marsh), and originally was so labelled.

in tributaries. The following list contains a short description of these localities, with the Naiades found at each of them:

Duck River, Centreville, Hickman Co., Tenn. (Aug. 29, Sept. 3 and 4, '21):

Riffles from below R. R. bridge to above wagon bridge, and quiet pool above the latter, distance of a little over a mile.

Water low and clear, so that conditions were favorable. Many dead shells were seen on the gravel bars and in the water, but living shells were scarce. Altogether this place had the appearance as if the Naiades had been partially killed off at some time, and that the fauna had not yet recovered. The living shells generally were old (yet a few young *Praptera alata* were found), and the number of species is comparatively small.

Between Columbia and Centreville, chiefly to the south of the river, are extensive phosphate mines, from which, at times, very muddy water reaches the river. But I cannot imagine what injurious substances it contains. There are or were also iron mines in the vicinity. But the fact is evident that normal conditions for Naiad life do not prevail here. It should be noted, on the other hand, that the *Pleurocerid*-fauna * of this place was extremely plentiful and rich in forms. The Naiades ascertained to exist here are the following:

1. *Megalonaias gigantea*
2. *Amblema costata*
3. *Quadrula pustulosa*
4. *Quadrula quadrula*
5 *Quadrula verrucosa*
6. *Cyclonaias tuberculata* (seen only)
7. *Lasmigona complanta*
8. *Ptychobranchus fasciolare*
9. *Obilquaria reflexa*
10. *Truncilla donaciformis*
11. *Leptodea fragilis*
12. *Proptera alata*
13. *Lampsilis anodontoides*

Only Nos. 1, 2, 3, 5, 11, and 12 of these were found living.

Duck River, Ben. Maury Co., Tenn. (Sept. 2, '23):

A small place of this name is located about one and a half mile west of the river, near the lower end of "Alexander Bend" (on Topogr. Atlas Sheet Columbia). Along the river, this is about 7 miles below Columbia.

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* Partially reported upon by Goodrich, Nautilus, 35. Octob. '21, p. 58-59.

A large gravel bar at the lower end of a quiet pool obstructs the river. At highwater there are two branches, but the smaller (left) does not contain water at low stage. At the time of my visit the water was muddy, so that no living shells could be seen; but they were found in good numbers by feeling for them in the larger (right) branch, where the quiet water of the pool begins to rush down, past the gravel bar. The river apparently was not at the lowest stage, so that specimens (and probably additional species) in the deeper water of the channel (three or more feet) could not be obtained. All forms were alive, except those marked.

1. *Ambiema costata*
2. *Quadrula pustulosa*
3. *Quadrula verrucosa*
4. *Quadrula cylindrica*
5. *Cyclonaias tuberculata*
6. *Lexingtonia dolabelloides*
7. *Lexingtonia dolabelloides conradi.*
8. *Pleurobema cordatum catillus*
9. *Pleurobema oviforme holstonense*
10. *Elliptio dilatatus*
11. *Lasmigona costata*
12. *Lasmigona complanata*
13. *Strophitus rugosus* (dead)
14. *Ptychobranchus fasciolare* (dead)
15. *Obovaria subrotunda lens*
16. *Actinonaias carinata*
17. *Actinonaias pectorosa*
18. *Proptera alata* (seen only, dead)
19. *Lampsilis ovata*

Duck River, Columbia, Maury Co., Tenn. (Aug. 26 and Sept. 1, '21, and Sept. 6, '22):

I collected about two miles below the town of Columbia, immediately above the mouth of Rutherford Creek. By a gravel bar, the river is divided into two branches, above this is a quiet pool. The shells were in the larger, deeper, left branch, in a similar situation to that at Ben. At my three visits, the condition of the river was about the same, with the water at low stage, but somewhat muddy. Many shells, in a few inches of water, were seen, but the majority was found by feeling for them. The locality was not only rich in species, but also in individuals, the latter crowding close together in the gravel. Most of the species were found alive, except those marked.

1. *Fusconaia barnesiana*
2. *Megalonaias gigantea*
3. *Amblema costata*
4. *Quadrula pustulosa*
5. *Quadrula verrucosa*
6. *Quadrula intermedia* (dead)
7. *Quadrula cylindrica* (dead)
8. *Cyclonaias tuberculata*

9. *Lexingtonia dolabelloides*
10. *Lexingtonia dolabelloides conradi*
11. *Pleurobema cordatum*
13. *Pleurobema cordatum pyramidatum*
14. *Pleurobema oviforme*
15. *Pleurobema oviforme holstonense*
16. *Elliptio dilatatus*
17. *Lastena lata*
18. *Lasmigona costata*
19. *Lasmigona complanata*
20. *Alasmidonta marginata* (seen only, dead)
21. *Strophitus rugosus*
22. *Ptychobranchus fasciolare*
23. *Ptychobranchus subtentum*
24. *Obovaria subrotunda*
25. *Obovaria subrotunda lens*
26. *Actinonaias carinata*
27. *Actinonaias pectorosa*
28. *Truncilla truncata*
29. *Leptodea fragillis*
30. *Proptera alata* (seen only, dead)
31. *Conradilla caelata*
32. *Medionidus conradicus* (dead)
33. *Lampsilis ovata*
34. *Lampsilis ovata ventricosa*
35. *Lampsilis fasciola*
CF. *Dysnomia triquetra*
37. *Dysnomia brevidens*
38. *Dysnomia capsaeformis*

Duck River, four miles east of and above Columbia, Maury Co., Tenn. (Sept. 5, '22):

This is at the extremity of a big meander of the river, below a covered bridge and an old dam, gone into decay. The water rushes fall-like through a gap in the dam. Immediately below, on the left bank, is a large gravel bar, covered with numbers of dead shells. Below this bar the water is more quiet, forming an eddy with mud-covered gravel. Here I found some living shells, in a depth of 2 to 3 feet, by feeling for them. The water was rather muddy, but near low-water stage. Most of the shells were gathered dead from the gravel bar, only *Amblema costata* and *Cyclonaias tuberculata* were found alive.

1. *Megalonaias gigantea*
2. *Amblema costata*
3. *Quadrula pustulosa*
4. *Quadrula fragosa*
5. *Quadrula verrucosa*
6. *Cyclonaias tuberculata*
7. *Elliptio dilatatus* (seen only)
8. *Lasmigona costata*
9. *Lasmigona complanata*
10. *Alasmidonta marginata*
11. *Ptychobranchus fasciolare*
12. *Obovaria subrotnuda lens* (seen only)
13. *Actinonaias pectorosa*
14. *Lampsilis ovata ventricosa*
15. *Dysnomia triquetra* (seen only)

Duck River, Leftwich, Maury Co., Tenn. (Sept. 3, '23):

Below Leftwich Bridge is a bush-covered island or islands, dividing the river into several branches. I selected the left

one, which is narrow, rocky and gravelly, rather deep in places, but with a number of shallower riffles. The stage of the water was fairly low, but the water was muddy, just beginning to clear. No shells were found by sight, all by feeling, mostly in a swiftly flowing portion in one to two feet of water, on gravelly bottom. All were alive.

1. *Amblema costata*
2. *Quadrula pustulosa*
3. *Quadrula verrucosa*
4. *Cyclonaias tuberculata*
5. *Lexingtonia dolabelloides conradi*
6. *Pleurobema cordatum catillus*
7. *Pleurobema cordatum pyramidatum*
8. *Elliptio dilatatus*
9. *Lasmigona costata*
10. *Alasmidonta marginata*
11. *Ptychobranchus subtentum*
12. *Obovaria subrotunda lens*
14. *Conradilla caelata*
15. *Medionidus conradicus*
16. *Lampsilis ovata*
17. *Lampsilis fasciola*
18. *Dysnomia triquetra*
19. *Dysnomia capsaeformis*

Duck River, Lillard's Mills, Marshall Co., Tenn. (Aug. 25, '23):

This is below an old dam. The river is broad, forming a ford. The water was beginning to clear, and was nearly at low stage. For about two-thirds of the width of the river (from left bank), the water was very shallow, and some living shells were visible here. A gradually deepening channel was close to the right bank, in part densely overgrown with water weeds. Among these weed patches, on gravelly-sandy bottom, the majority of the Naiades was found by feeling for them. Current lively, in part strong. All species were found alive.

1. *Amblema costata*
2. *Quadrula fragosa*
3. *Quadrula verrucosa*
3. *Quadrula cylindrica*
5. *Cyclonaias tuberculata*
6. *Lexingtonia dolabelloides conradi*
7. *Pleurobema cordatum pyramidatum*
8. *Pleurobema oviforme*
9. *Elliptio dilatatus*
10. *Lasmigona costata*
11. *Alasmidonta marginata*
12. *Strophitus rugosus*
13. *Obovaria subrotunda lens*
14. *Actionaias pectorosa*
15. *Leptodea fragilis*
16. *Medionidus conradicus*
17. *Lampsilis ovata ventricosa*
18. *Lampsilis fasciola*
19. *Dysnomia florentina walkeri*
20. *Dysnomia capsaeformis*

Duck River, Wilhoite, Marshall Co., Tenn. (Aug. 27, '23):

Similar to the preceding place, below a dam. Water strongly, but irregularly, flowing, the shallower part on the right

bank, the deeper channel on the left. Plenty of water weeds. Conditions most favorable, water clear enough to see shells up to a depth of about eight to ten inches. The stage must have been low water, since many shells were found close to banks in a few inches of water. All species found alive.

1. *Fusconaia barnesiana*
2. *Fusconaia barnesiana bigbyensis*
3. *Amblema costata*
4. *Quadrula fragosa*
5. *Quadrula verrucosa*
6. *Quadrula cylindrica*
7. *Cyclonaias tuberculata*
8. *Lexingtonia dolabelloides conradi*
9. *Pleurobema cordatum catillus*
10. *Pleurobema cordatum pyramidatum*
11. *Pleurobema oviforme*
12. *Pleurobema oviforme argenteum*
13. *Elliptio dilatatus*
14. *Lasmigona costata*
15. *Strophitus rugosus*
16. *Obovaria subrotunda*
17. *Obovaria subrotunda lens*
18. *Carunculina moesta*
19. *Medionidus conradicus*
20. *Micromya fabalis*
21. *Lampsilis ovata*
22. *Lampsiliis ovata ventricosa*
23. *Lampsilis fasciola*
24. *Dysnomia triquetra*
25. *Dysnomia brevidens*
26. *Dysnomia florentina walkeri*
27. *Dysnomia capsaeformis*

Duck River, Shelbyville, Bedford Co., Tenn. (Sept. 1 and 3, '22) :

Also below a dam. River divided into a number of branches. In one of them, in and below a small riffle, in an eddy, with gravel and mud, the majority of the Naiades was found, in part by sight, in part by feeling for them. Water clear to a depth of about a foot, and apparently at low stage. Shells all found alive, with one exception, so marked.

1. *Fusconaia barnesiana*
2. *Fusconaia barnesiana bigbyensis*
3. *Amblema costata*
4. *Quadrula verrucosa*
5. *Cyclonaias tuberculata* (dead)
6. *Lasmigona costata*
7. *Anodonta grandis*
8. *Alasmidonta minor*
9. *Alasmidonta marginata*
10. *Strophitus rugosus*
11. *Obovaria subrotunda lens*
12. *Carunculina moesta*
13. *Medionidus conradicus*
14. *Micromya taeniata*
15. *Micromya vanuxemensis*
16. *Lampsilis ovata ventricosa*
17. *Dysnomia triquetra*
18. *Dysnomia turgidula*

Duck River, Normandy, Bedford Co., Tenn. (Aug. 22, '23) :

A gravel bar, forcing the river to one (left) side. Water

strongly flowing, not very clear. Shells found by feeling, in gravel, and not very abundant. All alive.

1. *Fusconaia barnesiana*
2. *Fusconaia barnesiana bigbyensis*
3. *Alasmidonta minor*
4. *Strophitus rugosus*
5. *Ptychobranchus subtentum*
6. *Medionidus conradicus*
7. *Micromya taeniata*
8. *Micromya vanuxemensis*

Duck River, Coffee Co., Tenn. (Aug. 22, '23):

This is three miles east of Normandy. A ford, the river divided into several strongly flowing branches. Water not very clear. In a quiet eddy, in mud, a number of living specimens of *Carunculina cylindrella* were found. At another place, in a very small, strongly flowing connecting branch between two larger branches, two living specimens of *Lexingtonia dolabelloides conradi* were secured, both apparently washed out of deeper water.

Duck River, Manchester, Coffee Co., Tenn. (Aug. 21, '23):

Below bridge, northwest of town. Water, crystal-clear (a dam some distance above), flowing over solid bed-rock (honeycombed limestone). Under overhanging ledges of rock, in sand and mud, about half a dozen *Lasmigona holstonia* were found.

Buffalo River, Riverside, Lewis Co., Tenn. (Sept. 7, '22):

Close to, and below R. R. station. River only of creek-size, full of riffles and more quietly flowing water; water clear. Naiades abundant everywhere, on gravelly, sandy, and muddy bottom. All species found alive.

1. *Fusconaia barnesiana*
2. *Fusconaia barnesiana bigbyensis*
3. *Lexingtonia dolabelloides conradi*
4. *Pleurobema oviforme*
5. *Pleurobema oviforme argenteum*
6. *Lasmigona costata*
7. *Alasmidonta minor*
8. *Alasmidonta marginata*
9. *Strophitus rugosus*
10. *Ptychobranchus subtentum*
11. *Obovaria subrotunda lens*
12. *Actionaias pectorosa*
13. *Carunculina cylindrella*
14. *Micromya nebulosa*
15. *Micromya taeniata*
16. *Micromya vanuxemensis*
17. *Lampsilis ovata ventricosa*
18. *Lampsilis fasciola*

Garrison Creek, Wartrace, Bedford Co., Tenn. (Sept. 2, '22):

From R. R. bridge, south of town, one to two miles upward. Creek small, everywhere fordable, with great variety of conditions of current, bottom, etc. Shells chiefly at one place, in a riffle in very shallow water (a few inches deep), in gravel, not plentiful, but well visible in the clear water. All alive, except the one not taken.

1. *Fusconaia barnesiana*
2. *Fusconaia barnesiana bigbyensis*
3. *Lasmigona costata*
4. *Strophitus rugosus*
5. *Medionidus conradicus*
6. *Micromya vanuxemensis*
7. *Lampsilis ovata ventricosa* (seen only, dead)
8. *Lampsilis fasciola*

ENUMERATION OF FORMS WITH TAXONOMIC AND GEOGRAPHICAL REMARKS. *

1. *Fusconaia barnesiana* (Lea).

Duck R., Columbia, Wilhoite, Shelbyville, Normandy; Buffalo R., Riverside; Garrison Cr., Wartrace.—Previously reported from Columbia (as *U. validus* and *barnesianus*) (Hinkley and Marsh).

A *Cumberlandian type*, not in the interior basin (Mississippi and Ohio.)

Cumberland River, Tenn. (without exact locality) is the type-locality, but it has not been found nor been mentioned by Wilson & Clark (1914), but probably *Pleurobema crudum* (i. c. p. 57), if correctly identified, stands for the var. *tumescens* (large-river-form). The latter form is known from South Fork Cumberland, and also has been given by Hinkley and Marsh from Nashviile. *F. barnesiana* is widely distributed in the Tennessee drainage, below and above Walden Gorge, in rivers of medium size.

Of this form of the medium rivers only comparatively few specimens have been found by myself in Duck River, yet one of them (a female from Columbia) is very interesting, because it demonstrates the identity of *U. validas* Lea (Duck River) with this. It is almost a counterpart of Lea's figure, only

* With regard to synonymy and nomenclature, compare: Ortmann, A. E. and Walker, B. Occas. Pap. Mus. Mich. 112, 1922.

slightly larger. Its diameter is 47% of the length, the same as that given by Simpson ('14 p. 750), while Lea's figure would give 49%. *U. validus* ('71) is thus an additionel synonym to *U. barnesianus* ('38) and corresponds most closely to *U. lyoni* Lea ('65).

2. *Fusconaia barnesiana bigbyensis* (Lea).

Duck R., Wilhoite, Shelbyville, Normandy; Buffalo R., Riverside; Garrison Cr., Wartrace.—Type locality: Big Bigby Creek (Lea).

At the localities where I found this form, it is the prevailing one, and it is not rare. The measurements confirm my view, that this is the compressed headwaters form of *F. barnesiana.* Also the larger size attained by *bigbyensis* is seen in specimens from Wartrace.

This flat form has not been reported from the Cumberland, but it is found abundantly in small streams of the lower and upper Tennessee region, going up into Virginia. My identification of the upper Tennessee specimens as *bigbyensis* is thus fully justified.

The large-river-form, *F. barnesiana tumesens*, has not been found in Duck River, but it is in the Cumberland (as *crudus*), and in the Tennessee from the Mussel Shoals to the Knoxville region.

3. *Megalonaias gigantea* (Barnes).

Duck River, Centreville, Columbia, above Columbia.—Scarce.—Reported from Columbia by Hinkley and Marsh.

In the Cumberland in the lower part up to Wayne County, Ky. At the Mussel Shoals of the Tennessee in northern Alabama; absent in the upper Tennessee. Widely distributed in the larger rivers of the interior basin (Mississippi, Ohio, etc.).

4. *Amblema costata* Rafinesque.

Duck R., Centreville, Ben, Columbia, above Columbia, Leftwich, Lillard's Mills, Wilhoite, Shelbyville.—Known from Columbia (Hinkley and Marsh, Marshall).

Widely distributed in the Cumberland and its tributaries (reported by Wilson and Clark from Cumberland proper as

Quadrula perplicata, passing in the upstream direction into *Qu. undulata* (equals) *A. costata*). In the Tennessee and its tributaries below and above Walden Gorge also abundant, going way up into the Clinch, Holston, French, Broad, etc.

Common in the Mississippi and Ohio drainages, but represented there, in the largest rivers, by forms called *A. perplicata* and *peruviana*.

5. *Quadrula pustulosa* (Lea).

Duck R., Centreville, Ben, Columbia, above Columbia, Leftwich.—Known from Columbia (Hinkley & Marsh).—Belongs to the lower and middle part of the river, not rare, at Columbia plentiful.

Abundant in the interior basin. In the Cumberland up to the falls; below Walden Gorge in Tennessee proper and lower parts of some tributaries; in the upper Tennessee up to the Knoxville region.

6. *Quadrula quadrula* (Rafinesque).

Duck River, Centreville, apparently not rare, since a good many dead shells were seen.—*New to the Duck River fauna.*

This species is common in the larger rivers of the interior basin, but has not been reported from the Cumberland by Wilson and Clark, and is not known from the Tennessee from the Mussel Shoals upward, but it is represented in the Cumberland and at the Mussel Shoals by *Qu. fragosa* (see next species). My specimens from Centreville are this, and not *fragosa*, of considerable size, with more or less transverse shape, the nodules only moderately developed, and the color of the epidermis typical.

7. *Quadrula fragosa* (Conrad).

Duck R., above Columbia, Lillard's Mills, Wilhoite.—Reported from Columbia (Hinkley and Marsh).—Only a few specimens taken by myself.

Wilson and Clark give this for Cumberland River, up to Wilson Co., Tenn., and from lower Harpeth river. At the Mussel Shoals of the Tennessee (specimens in Carnegie Museum, collected by H. H. Smith). Missing, as well as *Qu. quadrula*, in the upper Tennessee. The Carnegie Museum pos-

sesses a single specimen from the Cumberland at Nashville, confirming the record of Wilson and Clark. It has been reported from a number of places in the interior basin, but its geographical relation to *Qu. quadrula* is not clear. The fact of its occurrence in central Tennessee and northern Alabama might indicate that it is the upstream representative of Qu. *quadrula*, and this surely is the case in Duck River.

This species is hard to distinguish from *Qu. quadrula*, as admitted by Simpson ('14 p. 844). It differs by the more rounded-quadrate (not transverse) outline, with the nodules of the surface more strongly developed, and the brown, rayless epidermis. Yet there are specimens, which connect the two, but I have not found any intergrades in Duck River, where this species is found distinctly farther upstream than *Qu. quadrula*.

8. *Quadrula verrucosa* (Rafinesque).

Duck R., Centreville, Ben, Columbia, above Columbia, Leftwich, Lillard's Mills, Wilhoite, Shelbyville.—Reported from Columbia by Hinkley and Marsh.—Fairly abundant all along the river.

Widely distributed in the interior basin (and elsewhere). In Cumberland R., up to the falls, and also in some tributaries; common in the lower Tennessee and most of its tributaries. In the upper Tennessee known only from Hiwassee River, and missing in the Knoxville region and above.

9. *Quadrula intermedia* (Conrad).

Duck R., Columbia.—Given from the same place by Hinkley and Marsh.—I found only a single dead shell.

A Cumberland type, not found in the interior basin.

Rare in the upper Cumberland (reported as *Qu. tuberosa*). In the Tennessee at the Mussel Shoals and at Bridgeport, Ala., in the upper Tennessee chiefly toward the headwaters, and rare.

10. *Quadrula cylindrica* (Say).

Duck R., Ben, Columbia, Lillard's Mills, Wilhoite.—Reported from Columbia by Hinkley and Marsh.—Only a few specimen found by myself at each place. All over the interior re-

gion (and elsewhere). Also in Cumberland and Tennessee Rivers, up to Virginia, in larger and smaller streams.

11. *Cyclonaias tuberculata* (Rafinesque).

Duck R., Centreville, Ben, Columbia, above Columbia, Leftwich, Lillard's Mills, Wilhoite, Shelbyville.—Reported from Columbia by Hinkley and Marsh.—At most places quite abundant.

All over the interior basin, and abundant in the Cumberland, lower and upper Tennessee, in larger and smaller rivers, avoiding only the headwaters.

12. *Lexingtonia dolabelloides* (Lea).

Duck R., Ben, Columbia.—Reported from the latter place by Hinkley and Marsh (as *U. circumactus*), and abundant.

A *Cumberland type*, but peculiar to the Tennessee R., from the Mussel Shoals upward to the Knoxville region. Apparently missing in the Cumberland, although one of the synonyms (*U. subglobatus* Lea) has been given for (Florence, Ala., and) Nashville, Tenn. But it has never been found there subsequently, and is missing in the list of Wilson and Clark. It is a form of larger rivers, and represented, in the smaller ones, by the next form, and this holds good also for Duck River.

13. *Lexingtonia dolabelloides conradi* (Vanatta).

Duck, R., Ben, Columbia, Leftwich, Lillard's Mills, Wilhoite, Coffee Co.; Buffalo R., Riverside.—*New for Duck River system.*

Distribution similar to the preceding form. A *Cumberlandian type*, not reported from the Cumberland, but abundant in the lower and upper Tennessee, chiefly in the smaller streams and headwaters.

The gradual transition of *dolabelloides* into *conradi* is beautifully shown in Duck River. While at Ben and Columbia a certain proportion of the specimens falls under *dolabelloides* (diameter 50% of length or more), farther up only the compressed form (*conradi*) occurs (dia. less than 50%). At Wilhoite, in Coffee County, and in Buffalo River (Riverside) the diameter falls as low as 41 and 40%.

14. *Pleurobema cordatum* (Rafinesque).

Duck R., Columbia, rare.—*New to Duck River.*

Abundant in the Cumberland, and in the Tennessee up to the Knoxville region, generally associated with several of its varieties. Also abundant in the interior basin, chiefly in the Ohio, and preferring larger rivers.

The typical *cordatum* is in Duck River, but apparently rare; a fine, large specimen from the Sterki collection (in Carn. Mus.), without exact locality, is this, and I have found several at Columbia, which should be placed here, which are more or less typical, some of them, however, inclining by shallow radial furrow toward var. *catillus*, or by reddish nacre toward var. *pyramidatum*. The usual forms, in which the *cordatum*-group turns up in Duck River are the next two.

15. *Pleurobema cordatum catillus* (Conrad):

Duck R., Ben, Columbia, Leftwich, Wilhoite.—*New to Duck River.*

Distribution similar to that of the main species, and generally found associated with it. (However, west of the Mississippi it exists without *cordatum*).

This is decidedly more abundant in Duck River than the true *cordatum*, but it inosculates closely with the typical form, and also with the var. *pyramidatum*, having often reddish nacre.

Note: The *coccineum*-form of the *cordatum*-type, found occasionally in the Cumberland and Tennessee towards the headwaters, being merely a flattened *catillus*, has not been observed in Duck River.

16. *Pleurobema cordatum pyramidatum* (Lea).

Duck R., Columbia, Leftwich, Lillard's Mills, Wilhoite.—Given from Columbia by Hinkley and Marsh.

Distribution similar to that of the two preceding forms, and generally associated with them, but going a little farther upstream.

This is the most abundant form of the *cordatum*-group in Duck River, outnumbering the other two forms chiefly at the upper stations. The *pyramidatum*-type, however, is not well developed here, the shells being not extremely oblique, and

passing, in this character, into typical *cordatum*. The nacre is mostly red. The radial furrow is sometimes poorly developed, and specimens, which at the same time are little oblique, pass thus into *catillus*.

17. *Pleurobema oviforme* (Conrad).

Duck River, Columbia, Lillard's Mills, Wilhoite; Buffalo R., Riverside.—Reported from Columbia by Hinkley and Marsh (as: *clinchensis, lesleyi, and patulus*) * and from Duck River by Call (as *clinchensis* and *clavus*).

A *Cumberland type.*

From Cumberland River (South Fork and Rockcastle R.), *Pl. clava* has been reported by Wilson and Clark (if identification is correct), and the Carnegie Museum possesses two specimens of *clava*, labeled: Cumberland R., Tenn. The same form is present from the Mussel Shoals (Tuscumbia) from the Smith collection. I have seen it also in the Walker collection from Sequatchie R., Jasper, Marion County, Tenn. But it is sure that also *Pl. oviforme* is in the Cumberland drainage, for I collected myself a fine set of it in W. Fk. Stones R., Murfreesboro, Rutherford Co., Tenn. In the lower and upper Tennessee drainage *oviforme* is widely distributed, chiefly in the tributaries.

Pl. clava (Lamarck) is very closely allied to *oviforme*, and the latter may be easily mistaken for the former. This is the case in Call's report of *clava* from Duck River. Since he figures this form (the figure probably is enlarged), we are able to control the identification, and pronounce it a rather typical *oviforme*. The beaks are less anterior than in *clava*, and the contrast between the anterior, swollen part of the shell, and the compressed posterior (producing a kind of radial furrow in *clava*) is not seen: the shell tapers gradually from the front part towards the end. I have specimens from Wilhoite, which entirely correspond to Call's figure, and even

* It is very doubtful, whether these names all rest upon correct identification, in view of their close resemblance to *Lexingtonia*-forms.

approach it in size (L. 68 mm. Call's figure is 80 mm long, but his text gives 53 mm).

But it should not be forgotten that specimens of *clava* in

the upper Ohio drainage sometimes approach the *ovidforme* type, chiefly in young shells, and it might be possible that somewhere the two supposed species actually intergrade.

18. *Pleurobema oviforme argenteum* (Lea).

Duck R., Wilhoite; Buffalo R., Riverside.—*New for this drainage.*—A few only at the first place, abundant at the latter.

Also *restricted to the Cumberland region.*

This headwaters-form has not been reported from the Cumberland, but it may be present there. In the tributaries and the headwaters of the lower and upper Tennessee it is abundant.

Also in Duck River it is only in the headwaters, yet associated with typical *oviforme,* and passing into it. I have not seen here the specimens of great size, frequently observed in the Tennessee drainage.

19. *Pleurobema oviforme holstonense* (Lea).

Duck R., Ben, Columbia.—Reported from Columbia by Hinkley and Marsh (as *pattinoides*).—I found only a few specimens.

Also a *Cumberland type.*

Not reported from Cumberland system, but known from the Tennessee proper, and the lower parts of some of its tributaries, from the Mussel Shoals up to the Knoxville region.

Thus also in Duck River the law holds good, that this form represents the large-river-form of *oviforme;* at Columbia the two forms intergrade.

20. *Elliptio crassidens* (Lamarck).

Reported by Hinkley and Marsh (as *gibber*) from Columbia, and by Marshall (as *crassidens*) from Duck River. I did not find it, and no trace of it was seen among the thousands of dead shells lying on the gravel bars. Thus it must be rare, and possibly it belongs to the lower parts of the river. But I do not hesitate to admit it to the list, since it is impossible to mistake this species.

Abundant in the larger rivers of the interior basin, chiefly the Ohio drainage. In the Cumberland it goes up to the falls, and is also in the lower part of some of the tributaries. In

the Tennessee it is everywhere, up to the Knoxville region and above, avoiding only the headwaters.

21. *Elliptio dilatatus* (Rafinesque).

Duck R., Ben, Columbia, above Columbia, Leftwich, Lillard's Mills, Wilhoite.—Reported (as *gibbosus*) from Columbia by Hinkley and Marsh.—Abundant.

Everywhere in the interior drainage, as well as in the Cumberland and Tennessee, from the Mussel Shoals to the headwaters in Virginia, and in most of the tributaries.

The color of the nacre, in Duck River, is mostly darker or lighter purplish, very rarely white.

22. *Lastena lata* (Rafinesque):

Duck R., Columbia.—Given from same place by Hinkley & Marsh.—I found only a single male.

Wherever found, this is a rare shell, but it has a wide distribution in the interior basin, chiefly the Ohio drainage, going up, in the Cumberland, to Burnside, Pulaski County, Ky., It is in the lower Tennessee at the Mussel Shoals and in lower Elk River, and goes up, in the upper Tennessee and Clinch Rivers, to Virginia.

23. *Lasmigona* (*Alasminota*) *holstonia* (Lea).

Duck R., Manchester.—*New for Duck River.*—Half a dozen specimens found.

A *Cumberlandian species*, but apparently missing in the Cumberland, and existing only in the Tennessee system. *)

Wilson and Clark do not report it from the Cumberland, and I have not been able to find a single record from this drainage. In the lower, as well as the upper Tennessee system, however, it is rather abundant, but restricted to the smaller streams. In the lower Tennessee (below Walden Gorge), I know it from Jones Creek, Bridgeport, Jackson Co., Ala., and Battle Creek, Dover, Marion Co., Tenn. In the headwaters of the upper Tennessee it goes up to Virginia.

Also in Duck River, it has been found only at the uppermost station.

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* In addition, it is also in the Alabama River system, but this does not interest us here.

24. *Lasmigona* (*Lasmigona*) *costata* (Rafinesque).

Duck R., Ben, Columbia, above Columbia, Leftwich, Lillard's Mills, Wilhoite, Shelbyville; Buffalo R., Riverside; Garrison Creek, Wartrace.—Reported from Columbia by Hinkley and Marsh.—Rather uniformly distributed, and abundant in the main river and tributaries.

A species of very wide distribution in the interior basin (and elsewhere), common also in the Cumberland, up to the falls, and the Tennessee, below and above the Gorge, going up to Virginia.

25. *Lasmigona* (*Pterosyna*) *complanata* (Barnes).

Duck R., Centreville, Ben, Columbia, above Columbia.—*New for Duck River.*—Not abundant, preferably in quiet pools above the riffles.

In quiet parts of larger rivers in the interior basin, also in the lower Cumberland, up to Harpeth River. Missing in the Tennessee from the Mussel Shoals upward.

26. *Anodonta grandis* Say.

Duck River, Shelbyville (three specimens in a muddy eddy below a riffle).—*New for Duck River.*

Of tremendous distribution in the interior basin (and elsewhere), but very rare in the Cumberland and Tennessee drainages. Reported from ponds near the Cumberland at Clarksville, Montgomery County, Tenn., and from Harpeth and Stones Rivers (found by myself in both of the latter). From the Tennessee, below the Gorge, I know it from Mountain Fork (of Flint R.), New Market, Madison Co., Ala. (Carn. Mus., coll. by H. E. Wheeler), and from the upper Tennessee it was known hitherto only from a pond near Knoxville. But recently (Aug. 16, '23) I found several specimens in Emory River (trib. to Clinch), at Wartburg, Morgan Co., Tenn.

This distribution appears as rather erratic and discontinuous. My Duck River specimens are not large, and represent the typical *grandis*, as found in streams of smaller size, but with the epidermis not so dark as usual. There are traces of

a purplish tint in the nacre. The beak-sculpture is normal. Max. size: L. 85, H. 54, D. 31 mm.

27. *Alasmidonta* (*Pressodonta*) *minor* (Lea):

Duck R., Shelbyville, Normandy; Buffalo R., Riverside.—*New for Duck River.*—Only a few specimens found.

A Cumberlandian type.

In the Cumberland above the falls (collected there by myself), and in some of the tributaries entering this river below the falls. In the Tennessee, below the Walden Gorge, it is in upper Elk River and the upper Sequatchie (Carnegie Museum); in the upper Tennessee it goes in the headwaters up to Virginia.

It is a typical small-creek form, strictly avoiding larger rivers. It is also in the uppermost Kentucky River, and I have seen specimens collected by E. Danglade in N. Fk. Kentucky River, Whitesburg, Letcher Co., Ky., which is not far from the headwaters of the Cumberland (See also: Danglade, Bur. Fish. Doc. 934. '22. p. 5). In the rest of the Ohio drainage, chiefly to the north of the Ohio River, it is represented by *A. calceolus* (Lea). The relations of the two species are obscure, but they are very closely allied.

28. *Alasmidonta* (*Decurambis*) *marginata* (Say).

Duck River, Columbia, above Columbia, Leftwich, Lillard's Mills, Shelbyville; Buffalo R., Riverside.—Reported from Duck River by Marshall.—Not abundant.

In the interior basin, and also in the Cumberland and its tributaries, up to the South Fork. Also in the Tennessee up to the headwaters. In the lower Tennessee it is absent or rare in the main river, but exists in most tributaries.

29. *Strophitus rugosus* (Swainson).

Duck R., Ben, Columbia, Lillard's Mills, Wilhoite, Shelbyville, Normandy; Buffalo R., Riverside; Garrison Cr., Wartrace.—Toward the upper parts rather abundant.—Reported from Columbia (as *schafferiana*) by Hinkley and Marsh.

Common everywhere in the interior basin (and elsewhere), chiefly in smaller rivers. Common also in the Cumberland and

Tennessee, up to the headwaters. In the Cumberland also above the falls.

Specimens from Duck River incline, in the main, toward the the form called *shaefferianus* (Lea), but not always. The epidermis generally is lighter and brownish, and also the nacre often shades into salmon tints, but the shape is very inconstant.

30. *Ptychobranchus fasciolare* (Rafinesque).

Duck R., Centreville, Ben, Columbia, above Columbia.—Not abundant.—Given for Columbia by Hinkley and Marsh (as *camelus*).

In the interior basin abundant, chiefly in the Ohio drainage. In Cumberland R., up to the falls, and in some tributaries. From the Mussel Shoals of the lower Tennessee, and several of its tributaries, into the upper Tennessee drainage, up to Virginia, but disappearing in the headwaters.

31. *Ptychobranchus subtentum* (Say).

Duck R., Columbia, Leftwich, Normandy; Buffalo R., Riverside. Only a few specimens found.—Reported from Columbia by Hinkley and Marsh.

A Cumberlandian type.

Found in the Cumberland from Rowena, Russell Co., Ky., up to the South Fork and the falls, and also in Rockcastle River. In the Tennessee, from the Mussel Shoals and the tributaries of the lower part up to the upper part, and well into the headwaters in Virginia. Most abundant in smaller streams above the range of *P. fasciolare,* and this seems to hold good also in Duck River.

32. *Obliquaria reflexa* Rafinesque.

Duck River, Centreville.—A single dead shell.—Reported from Columbia by Hinkley and Marsh.

Abundant in larger rivers in the interior basin. In the Cumberland in the main river up to the falls, and also in South Fork. In the Tennessee in the main river from the Mussel Shoals to the Knoxville region, entering here the lower parts of some tributaries.

33. *Cyprogenia irrorata* (Lea).

A single, very large specimen reported from Columbia by Hinkley and Marsh. I did not find a trace of it. But since the species is not easily to be mistaken, I admit it in the list.

Widely distributed in the Ohio drainage, the Cumberland, lower and upper Tennessee, preferring larger streams.

34. *Obovaria* (*Obovaria*) *retusa* (Lamarck).

Given from Columbia by Hinkley and Marsh. Since this species is easily recognized, it should be admitted, although I did not find it.

In the Ohio drainage, the Cumberland, and the Tennessee, up to the Knoxville region, but apparently rare in the Tennessee.

35. *Obovaria* (*Obovaria*) *subrotunda* Rafinesque.

Duck R., Columbia, Wilhoite.—Several specimens at the first place, only one at the other, standing close to the next form.—Hinkley and Marsh give it (as *circulus*) from Columbia.

In the interior basin chiefly in the Ohio drainage, in the larger rivers. In the Cumberland, this form and the next have not been separated, but apparently both are found, as usual, *subrotunda* farther down, *lens* farther up. In the Tennessee below the Gorge, this form has not been reported from the main river, but it is present but rare, in the Knoxville region.

36. *Obovaria* (*Obovaria*) *subrotunda lens* (Lea.).

Duck R., Ben, Columbia, above Columbia, Leftwich, Lillard's Mills, Wilhoite, Shelbyville; Buffalo R., Riverside.—More abundant than the main form, and taking its place in the upper reaches of the river.—*New for the system.*

Distribution similar to that of the main species, but preferring the smaller streams. It is in the Cumberland drainage (surely in Harpeth River, for *U. depygis* Conrad is a true *lens*), and quite frequent in tributaries of the lower Tennessee. In the upper Tennessee it is, like the main species, rare.

Also in Duck River it is evident, that *subrotunda* is the swollen large-river-form, *lens* the more compressed form farther up. A single specimen of *O. subrotunda*, found at Wilhoite,

makes an exception, but with a diameter of only 62% it stands close to *lens*. At Ben only two specimens were found, one of them, with the diameter of 59%, coming close to typical *subrotunda*.

37. *Actinonaias carinata* (Barnes).

Duck R., Ben, Columbia.—Not very abundant.—*New for Duck River.*

Very abundant in the interior basin, and chiefly in the Ohio drainage. The typical *A. carinata* is not found in the Cumberland and Tennessee, but is represented there by the var. *gibba* Simpson. This fact is extremely remarkable: the specimens from Duck River undoubtedly belong to the typical *carinata* (the "northern mucket"), and do not have the humped shape of the "southern mucket" (*gibba*). It is true, var. *gibba* is not very well marked, as specimens from the Cumberland and Tennessee often approach the Ohio-form; and, on the other hand, specimens from Green River, Kentucky, are again more like *gibba*. Yet, as a rule, the two forms are separable.

38. *Actinonaias pectorosa* (Conrad).

Duck R., Ben, Columbia, above Columbia, Leftwich, Lillard's Mills; Buffalo R., Riverside.—Abundant at Columbia and Leftwich.—Recorded by Hinkley and Marsh from Columbia (as *perdix*).

A *Cumberlandian form*, missing in the interior basin.

Reported, in the Cumberland, from Cloyd's Landing, Cumberland Co., Ky., to the South Fork and the falls, also from some of the tributaries. In the Tennessee, below the Walden Gorge, at the Mussel Shoals, and in several of the tributaries; in the upper Tennessee chiefly towards the headwaters, as far up as Virginia, sometimes quite abundant.

Also in Duck River, this species has its metropolis farther up in the river, than *A. carinata*.

39. *Plagiola lineolata* (Rafinesque).

Reported from Columbia by Hinkley and Marsh (as *securis*). Not seen by myself, but easily recognized. Thus it should be credited to Duck River.

Common in Ohio and Cumberland drainages. In the Tennessee up to the Knoxville region, but rare there.

40. *Truncilla truncata* (Rafinesque).

Duck R., Columbia.—Several specimens.—Reported from the same place by Hinkley and Marsh (as *elegans*).

Of very wide distribution in interior basin and elsewhere. In the Cumberland up to the South Fork and the falls, and also in some tributaries. In the lower Tennessee at the Mussel Shoals, in Bear Creek, and Paint Rock River; rare in the upper Tennessee in the Knoxville region.

41. *Truncilla donaciformis* (Lea).

Duck R., Centreville.—Only one dead shell.—Reported from Columbia by Hinkley and Marsh.

Distribution very much like that of the preceding species, but with some differences. It exists in the Cumberland and in the lower Tennessee (Mussel Shoals and Paint Rock River), but is missing in the upper Tennessee, where *T. truncata* is found.

42. *Leptodea leptodon* (Rafinesque).

Reported (as *tenuissimus*) by Hinkley and Marsh from Columbia. Easily recognized, and thus admitted. I may have overlooked it, since dead shells are not apt to be preserved very long.

A rare species, but widely distributed in the interior basin, the Cumberland, lower and upper Tennessee.

43. *Leptodea fragilis* (Rafinesque).

Duck R., Centreville, Columbia, Lillard's Mills.—Not abundant.—Reported from Columbia by Hinkley and Marsh (as *gracilis*).

Widely distributed in the interior basin. In the Cumberland all along the river up to the South Fork, but not in the tributaries. In the Tennessee below the Gorge, and some of its tributaries; also in the upper Tennessee, with the exception of the headwaters.

44. *Proptera alata* (Say).

Duck R., Centreville, Ben, Columbia.—*New for Duck River.*

Living specimens were taken at the first station, and they were not rare there (chiefly in the quiet pool above the riffles). At the other two localities only a few dead shells were seen.

Distribution very much like that of the preceding species, and generally abundant, also in the Cumberland and Tennessee, with exception of the headwaters. Prefers larger rivers, but sometimes also in smaller ones.

45. *Carunculina moesta* (Lea).

Duck R., Wilhoite, Shelbyville.—Several specimens.—*New for Duck River.*

A *Cumberlandian type*, missing in the interior basin (but represented there by *C. glans*). Reported from tributaries of the Cumberland; known from tributaries of the lower Tennessee, and locally from smaller streams in the upper Tennessee region.

My specimens from Duck River are quite typical in shape and color of epidermis and nacre.

46. *Carnuculina cylindrella* (Lea).

Duck R., Coffee Co.; Buffalo R., Riverside.—A number of specimens at the first locality, only one of the second.—Reported from Columbia by Hinkley & Marsh. Duck River is Lea's type locality.

A *Cumberlandian type*, but not known from the Cumberland drainage, and not known from the upper Tennessee. The Carnegie Museum possesses specimen from the lower Tennessee drainage: upper Elk River, and Flint River in Madison Co., Ala.

This species stands very close to *C. moesta*, but differs in paler (greenish-yellowish) epidermis, and paler nacre. The latter may be purplish, or of a peculiar yellowish-white tint. Such specimens are occasionally found in the upper Tennessee region, but always associated with *moesta*. In *C. cylindrella*, the shell is slightly more elongated, both in the male and female, and the postbasal dilatation of the female is less developed than in *moesta*. It is quite possible, that *cylindrella* is only a variety of *moesta*, but in my material from Duck River the two are sharply distinct.

47. *Conradilla caelata* (Conrad).

Duck R., Hickman Co. (Hartman coll.), Columbia, Leftwich.—Only one specimen at each of the latter two localities found by myself.—Found at Columbia by Hinkley and Marsh.

A *Cumberlandian type*, missing in the interior basin, and absent also from the Cumberland drainage. Restricted to the lower and upper Tennessee, from the Mussel Shoals, Elk and Flint Rivers (Morgan Co., Ala.), to the Clinch, Powell, and Holston Rivers, up into Virginia.

48. *Medionidus conradicus* (Lea).

Duck R., Columbia, Leftwich, Lillard's Mills, Wilhoite, Shelbyville, Normandy; Garrison Creek, Wartrace.—Locally abundant, chiefly at the upper stations.—Found at Columbia by Hinkley and Marsh.

A *Cumberlandian type*, not present in the interior basin, but common in the upper part and tributaries of Cumberland River (not above the falls), and in the lower and upper Tennessee drainage, chiefly in the tributaries, up to Virginia.

49. *Micromya fabalis* (Lea).

Duck R., Wilhoite.—Several specimens found by myself.—Reported from Columbia by Hinkley and Marsh, and by Marshall.

In the interior drainage chiefly in tributaries of the Ohio, not rare. Not reported from the Cumberland by Wilson and Clark, and apparently absent there, as well as missing in the Tennessee below Walden Gorge. Present, however, in the upper Tennessee, chiefly in the headwaters from the Knoxville region into Virginia.

It is quite possible that this species has been overlooked in the Cumberland and lower Tennessee.

50. *Micromya nebulosa* (Conrad).

Buffalo R., Riverside.—Abundant at this place.—*New for Duck River system.*

A Cumberlandian type, but represented in the interior basin by *M. iris.*

Of the many synonyms of this species, several have been originally reported from the Cumberland system: *U. cumber-*

landianus Lea, *notatus* Lea, admitted by Simpson as synonyms; and the following added by Ortmann: *U. obscurs* Lea; *simus* Lea. Call gives also *U. iris* from Rockcastle River. However, none of these has been mentioned from the Cumberland by Wilson & Clark. Yet *M. nebulosa* does exist in the Cumberland drainage, for I have found it myself in the upper Caney Fork at Riverhill, White Co., Tenn. (S. of Sparta), and in its tributary, Barren Fork, at McMinnville, Warren Co., Tenn., and further, the Carnegie Museum possesses specimens collected by C. Goodrich in September, 1923 in Pitman Creek, at Burnside, Pulaski Co., Ky.

In the Tennessee drainage below and above the Walden Gorge, this species is present. It is rare in the larger rivers, but practically everywhere in the smaller streams, and goes, in the headwaters, into Virginia.

Outside of the Cumberland region, it has not been positively found, although some of its synonyms have been occasionally reported; but probably all these records refer to *M. iris*, which, possibly, is only a variety of it.

It is remarkable that in the Duck River drainage, I found this species only in Buffalo River, but that it was extremely abundant here, and associated with, and hard to distinguish from, the next species. Probably it will be found in some other small tributaries of Duck River.

51. *Micromya taeniata* (Conrad).

Duck R., Shelbyville, Normandy; Buffalo R., Riverside.—Few at the first two localities, abundant at the third.—*New for Duck River.*

A Cumberlandian type, reported under various names (*taeniatus, pictus, punctatus*) from the upper Cumberland by Wilson and Clark. I found it myself in West Fork Stones River, and the Carnegie Museum has it from Pitman Creek, Burnside, Ky. (Goodrich). Also known from the lower Tennessee at the Mussel Shoals and from several tributaries in this region, but missing in the whole upper Tennessee system above the Gorge.

This species is very close to *nebulosa:* it is larger, and the color pattern is slightly different, consisting of rather broad,

more or less interrupted rays, often dissolving into isolated spots. Just the latter character is very variable, and has caused the creation of several nominal species. But I am unable, for instance, to distinguish: *taeniate*, *picta*, and *punctata*. The forms of this group require additional study, and also their relation to *M. nebulosa* should be investigated more closely.

Outside of the Cumberland region, in the interior basin, no shells of the *taeniata* type are known.

52. *Micromya vanuxemensis* (Lea).

Duck R., Shelbyville, Normandy; Buffalo R., Riverside; Garrison Creek, Wartrace.—Abundant at Shelbyville and Riverside.—*New for Duck River.* *)

A Cumberlandian type, not known in the interior basin (but represented in the upper Alabama drainage). From the Cumberland system, it has been reported by Wilson and Clark (W. Fk. Red R., Ringgold, Montgomery Co., Tenn.), and probably *lienosa* from the main river at Clarksville, from below the falls, and E. Fk. Stones R., also belongs here. In the lower and upper Tennessee this species is abundant, generally preferring the smaller streams.

However, specimens from larger rivers in the upper Tennessee drainage, as well as from the whole lower Tennessee drainage, and from Duck River, do not represent the typical phase of the species, and do not have, in the female, that characteristic constriction of the shell behind the postbasal expansion, or it is only weakly indicated (equals *pybasi*-type). Such forms approach *M. lienosa* (Conrad) of the Alabama system, and we apparently have here the actual transition between the two forms, which explains the fact that repeatedly the latter has been reported from the upper and lower Tennessee and from the Cumberland.

My specimens from the Duck system have mostly dark-purple nacre, often with whitish margin. But one female from Wartrace is entirely white inside. A male from Shelbyville

* Unless *U. nashvillensis*, reported by Hinkley & Marsh from Columbia, should be this. The large specimen of *M. vanuxemensis*, mentioned below, might suggest this.

has gigantic proportions: L. 75, H. 43, D. 27 mm. The normal maximum length is between 50 and 60 mm.

53. *Ligumia recta latissima* (Rafinesque).

Reported from Columbia by Hinkley and Marsh. It should be included in the list, since this species is unmistakable. I did not see a trace of it.

Common everywhere in the interior basin, the Cumberland, lower and upper Tennessee, but apparently rare in Duck River.

54. *Lampsilis anodontoides* (Lea).

Duck R., Centreville.—Rather abundant, but only dead shells found.—*New for Duck River.*

A common form in the larger rivers of the interior basin, going up, in the Cumberland, to Willson Co., Tenn. Also in lower Harpeth River. In the Tennessee, it is known only from the Mussel Shoals (Hinkley, Nautilus, 20, '06), but not higher up.

55. *Lampsilis ovata* (Say).

Duck R., Ben, Columbia, Leftwich, Wilhoite.—Not rare.—Mentioned from Columbia by Hinkley and Marsh.

A form of wide distribution in the Ohio drainage, chiefly in the larger rivers, but apparently missing from the lower Ohio westward and northward. In the Cumberland it is all along the main river up to the falls (transplanted above the falls). Also everywhere in the Tennessee proper, from the Mussel Shoals (and lower Paint Rock River) up to the Knoxville region, and going here upward a certain distance in the larger tributaries.

56. *Lampsilis ovata ventricosa* (Barnes).

Duck R., Columbia, above Columbia, Lillard's Mills, Wilhoite, Shelbyville; Buffalo R., Riverside; Garrison Creek, Wartrace.—Not rare.—*New for Duck River*

Distribution similar to that of the preceding form, often associated and intergrading with it, and gradually taking the place of it in the headwaters. In the Cumberland system chiefly in the tributaries. Everywhere in the Tennessee drain-

age, but again mostly in the tributaries and the headwaters, up to Virginia.

Also in Duck River, *ventricosa* gradually displaces *ovata* in the upstream direction. Intergrades between the two are frequent.

57. *Lampsilis fasciola* (Rafinesque).

Duck R., Columbia, Leftwich, Lillard's Mills, Wilholte; Buffalo R., Riverside; Garrison Cr., Wartrace.—Rather abundant. —Reported from Columbia by Hinkley and Marsh (as *perradiatus*) and Marshall (as *multiradiatus*).

Very widely distributed in the Ohio basin, yet apparently rare or missing in the Mississippi, preferring streams of medium or small size. In the Cumberland abundant, chiefly in the upper parts, below the falls, and in tributaries. Everywhere in the lower and upper Tennessee drainage, and most abundant in the tributaries up to the headwaters in North Carolina and Virginia.

58. *Dysnomia* (*Truncillopsis*) *triquetra* (Rafinesque).

Duck R., Columbia, above Columbia, Leftwich, Wilhoite, Shelbyville.—Rare.—Reported from Columbia by Hinkley and Marsh (as *triangularis*).

Frequent in the interior basin, chiefly in the Ohio drainage. Reported by Wilson and Clark from the Cumberland, up to Russell Co., Ky., and from Obey River. Of general distribution in the lower and upper Tennessee, in larger and smaller rivers.

59. *Dysnomia* (*Truncillopsis*) *brevidens* (Lea).

Duck R., Columbia, Wilhoite.—Only two living and one dead specimen found by myself.—Mentioned from Columbia by Hinkley and Marsh.

A Cumberlandian type, missing in the interior basin. Reported from the Cumberland at Nashville by Conrad, and by Wilson and Clark from Beaver Creek and the South Fork. Known from the lower Tennessee from the Mussel Shoals and Elk River. More abundant in the upper Tennessee in the Knoxville region and above.

60. *Dysnomia* (*Truncillopsis*) *lenior* (Lea).

Given from Columbia by Hinkley and Marsh. It could only

be confounded with *brevidens*, but since also the latter has been mentioned by the same authors, the identification must be accepted. I did not see it, but it is a rare species, easily overlooked.

The type locality is in Stones River (Cumberland drainage). In the Tennessee system, below the Gorge, it is frequent in Paint Rock River; in the upper Tennessee it is in the headwaters of the Clinch and Holston. Thus it is *a Cumberlandian type*, absent in the interior basin.

61. *Dysnomia* (*Pilea*) *turgidula* (Lea).

Duck R., Shelbyville.—Abundant.—Given from Columbia by Hinkley and Marsh (as *deviatus* and *turgidulus*).

A Cumberlandian type. * Reported by Lea from Cumberland River, but not by Wilson and Clark. Found in the lower Tennessee at the Mussel Shoals in Alabama (Lea), in Bear Creek, (Carn. Mus.), and Shoals Creek (Hinkley). In the upper Tennessee system it is in Holston and Emory Rivers.

This species is a close relation to *D. biemarginata* (Lea) (see: Ortmann, Proc. Amer. Philos. Soc. 57, '18, p. 590), and may be the headwaters-form of it. *D. biemarginata* is known from the lower Tennessee and its larger tributaries (Elk and Paint Rock Rivers). Aside from Lea's record for *turgidula from* Cumberland River, *D. biemarginata* is in the Cumberland and the South Fork at Burnside, Ky. (Walker collection).

The material collected by myself at Shelbyville is very fine, containing a good number (about two dozen) of males and females (among the latter gravid ones) of different ages.

62. *Dysnomia* (*Pilea*) *florentina walkeri* (Wilson and Clark).

Duck R., Lillard's Mills, Wilhoite.—Rare.—This is probably the form reported as *florentinus* from Columbia by Hinkley and Marsh.

A Cumberlandian type, missing in the interior basin. Found

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* It is present also in the Ozark region, in Missouri as *Truncilla curtisi* Frierson and Utterback (Amer. Midl. Natural., 4, 1916, p. 90). This peculiar distribution is found in some other Cumberlandian forms (*Carunculina moesta*, for instance), and is highly interesting and significant, but may be dismissed for the present.

in the Cumberland system at the type locality, E. Fk. Stones R., Walterhill, Rutherford Co., Tenn. (Wilson and Clark), and in Harpeth R., Belleview, Davidson Co., Tenn. (dead shell collected by myself). It exists in tributaries of the Tennessee, below the Walden Gorge; Flint R., and Hurricane Cr., Gurley and Maysville, Madison Co., Ala. (Carn. Mus.), and Limestone Cr., Mooresville, Limestone Co., Ala. (Walker collection), and in the upper Tennessee drainage in Holston R., up to Virginia (see: *Truncilla florentina* and *walkeri*, Ortmann, Proc. Amer. Philos. Soc. 57, 1918, pp. 591, 592).

D. florentina and *walkeri* are closely allied, and intergrade with each other. Specimens from the lower Holston (above Knoxville), which I mentioned (l. c) as *Tr. florentina*, are intergrades, but should be better placed with *walkeri*, which should be regarded as a variety of *florentina*.

Since this has not been fully realized hitherto, I think it would be in order to substantiate this by a fuller account of the material at hand.

At the Mussel Shoals, the type locality for *florentina*, both the height and diameter of the *male* shell is great, the H. being from 75-79% (average 77%) of the length. At all other localities (Stones R., Duck R., Flint R., lower and upper Holston) the H. is less, between 66 and 75%, and only in the lower Holston it reaches the maximum of 75%. Thus, for the *male*, *the H. of the shell can be used to distinguish florentina and walkeri*, the former having the H. of 75% or over, the latter less than 75%, keeping in mind, that in the lower Holston transitional specimens are present.

For the *female*, H. is not important, for, at the Mussel Shoals, it averages 73.5%, in Duck R., 75%, in Flint R, 76%, in the lower Holston 76%, upper Holston 77%, Harpeth R., 73%, Stones R., (type loc. for *walkeri*) 73%, the minima and maxima of the several localities broadly overlapping. For this condition apparently the great variability in the development of the postbasal expansion is responsible.

The D. of the *male* at the Mussel Shoals also is great. It varies from 50 to 62%, with an average of 57%. At other places, it is distinctly less, as is shown by the following aver-

ages: Duck R., 45%, Flint R., 45%, lower Holston, 50%, upper Holston, 40%, Stones R., 45.5%. Again we have, in the lower Holston, a close connection of the two forms, the D. varying here from 47 to 52%, so that the males from the lower Holston stand very near to the typical *florentina*, although the latter (from the Mussel Shoals) are in the average more swollen.

It is the Diameter of the shell, by which the females of the two forms may be separated. At the Mussel Shoals, it is 50 to 53% (average 51.5%, but comparatively few specimens at hand.) At the other localities it is never over 50%, and it is again in the lower Holston, where this figure reaches the maximum, the average being 47%. For the rest, it is considerably lower: 42% in Duck R., 43% in Flint R., 41% in the upper Holston, 41% in Harpeth R., and 40% in Stones R.

Thus we get the following diagnostic characters:

Male: H. 75% or over; D. 50% or over. Female: D. 50% or over ---------- *florentina*

Male: H. under 75% D. mostly under 50%. Female: D. less than 50% ---------- *walkeri*

This is an additional case to those given by me (Proc. Amer. Philos. Soc. 59, '20, p. 269 ff.), where the *Diameter (or obesity), of the shell changes with the size of the river:* the larger rivers have the swollen *florentina* (Mussel Shoals only, thus far); in the smaller ones this passes into the more compressed *walkeri*. In the lower Holston we have the actual intergrades.

There is an additional character to be considered. This is absolute size. According to the material at hand, *florentina* from the Mussel Shoals, and *walkeri* from the Duck, Flint, and lower Holston, are rather small (maximum L. in males 39 to 42 mm., in females 33 to 38 mm), while in upper Holston, Harpeth, and Stones, the maxima are: males 51 to 52 mm., females, 48 to 58 mm. This is a great contrast, but cannot be used for the distinction of the two forms, since it does not apply to the *walkeri*-type of Duck, Flint, and lower Holston. But, of course, it again suggests the close connection of these forms.

The males of *D. florentina walkeri*, closely resemble those of the next species (*capsaeformis*), but they differ chiefly in

color. The epidermis is yellowish-brown, with greenish rays, the latter not very sharply defined, but never confluent into a broad, dark-green area upon the flattened part of the disk. *D. capsaeformis* is greenish, with darker rays, and a dark green area (corresponding to the dark green expansion of the female), which is practically always visible, and often very striking.

63. *Dysnomia* (*Pilea*) *capsaeformis* (Lea).

Duck R., Columbia, Leftwich, Lillard's Mills, Wilhoite.—Rather abundant.—*New for Duck River.*

A Cumberland type, not found outside of this region, but quite abundant in it. Known in the Cumberland from Nashville up to the South Fork. Everywhere in the lower Tennessee in the main river and most of its tributaries, and in the upper Tennessee in larger and smaller streams up to Virginia.

In all females collected, the "pad" of the mantle margin was grayish to blackish, and never of that peculiar blueish or greenish-white so often seen in upper Tennessee specimens.

FAUNISTIC AFFINITIES OF THE DUCK RIVER NAIADES.

My chief object in publishing the above list of Duck River Naiades is to ascertain the relations of this fauna to others, and its probable origin. But not all species can be used for this purpose. There is a large number of them, which are very widely distributed, without pointing to any particular river system, and this holds good for all those, which are rather uniformly found in the "interior basin" (to which Duck River belongs at the present time), that is to say, chiefly in the Ohio, Cumberland, and Tennessee, below and above the Walden Gorge. The following forms belong to this class:

1. *Amblema costata*
2. *Quadrula pustulosa*
3. *Qu. verrucosa*
4. *Qu. cylindrica*
5. *Cyclonaias tuberculata*
6. *Pleurobema cordatum*
7. *Pl. cord. catikus*
9 *Pl. cord, pyramidatum*
9. *Elliptio crassidens*
10. *Ell. dilatatus*
11. *Lastena lata*
12. *Lasmigona costata*
13. *Anodonta grandis*
14. *Alasmidonta marginata*
15. *Strophitus rugosus*
16. *Ptychobranchus fasciolare*
17. *Obilquaria reflexa*
18. *Cyprogenia irrorata*
19. *Obovaria retusa*
20. *Ob. subrotunda*

21. *Ob. subrotunda lens*
22. *Plagiola lineolata*
23. *Truncilla truncata*
24. *Leptodea leptodon*
25. *L. fragilis*
26. *Proptera alata*
27. *Ligumia recta latissima*
28. *Lampsilis ovata*
29. *L. ov. ventricosa*
30. *L. fasciola*
31. *Dysnomia triquetra*

Some of these are decidedly rare in the upper Tennessee, namely: *Quadrula verrucosa, Anodonta grandis, Obliquaria reflexa, Obovaria retusa, Obovaria subrotunda, Obovaria subrotunda lens, Plagiola lineolata;* and these lead us to another group of species, which have a similar wide distribution as those named above, but are *missing in the upper Tennessee:*

32. *Megalonaias gigantea*
33. *Quadrula fragosa*
34. *Truncilla donaciformis*
35. *Lampsilis anodontoides*

These 35 forms make 56% of the total of the Duck River fauna, that is to say, over half of it consists of elements which have a very wide distribution over most of the present interior drainage.

These species do not tell us more than the obvious fact, that the Duck River fauna largely belongs to the Mississippi-Ohio basin, as it ought to, since, at the present time, Duck River (as well as Cumberland and Tennessee) form part of this hydrographic basin. The four last named forms, however, suggest that the immigration was in this region in an upstream direction, for these species have not been able to reach the most remote part of this drainage, the upper Tennessee. This may be the case also in at least some of the others, and it should be pointed out, that, with the exception of *Anodonta grandis,* which is a small creek- and pond-form, all these species are either large-river-forms, or else inhabit indiscriminately larger and smaller streams. This would place their centre of radiation well downstream, i. e. near the centre of the interior basin, in the region of the lower Ohio. Of course, it is impossible to exactly locate the place of origin, without detailed study of the range of each species, and, on the other hand, it is quite possible, that some of them actually have originated in the Cumberland region, whence they migrated down the rivers toward the Ohio.

To the above list we are to add several other shells, which

seem to have had a similar upstream direction of migration, but which did not reach all of the Cumberland-Tennessee region.

First, there is a species widely distributed in the interior basin, and found in the Cumberland, but altogether missing in the Tennessee:

36. *Lasmigona complanata*

Further, there are two species, also of wide distribution in the interior basin, and existing also in Duck River, but absent from both the Cumberland and Tennessee drainages:

37. *Quadrula quadrula* 38. *Actinonaias carinata*

And finally a species should be mentioned of rather irregular distribution:

39. *Micromya fabalis*

This is in Duck River and the upper Tennessee, but not in the Cumberland and the lower Tennessee. In the Ohio-drainage, it is abundant, and thus it surely falls in this general group of widely distributed species.

Thus the percentage of forms (39) which probably or possibly are to be regarded as *elements belonging to the interior basin* (Ohio-drainage chiefly) rises to about 62%.

All other species of Duck River (about 38%) are not known from the interior basin, i. e. not from outside of the Cumberland-Tennessee drainages. They are the *Cumberlandian* types, which designation may be properly used for them, because they largely belong to the Cumberland Plateau and the Great Allegheny Valley (upper Tennessee). A *Cumberland Region*, in this sense, and applied to *freshwater forms*, naturally recalls the "Cumberland subregion" introduced by W. G. Binney (See: Bull. U. S. Nat. Mus. No. 28, '85 p. 33) for the *Land-Gastropods*, forming a subdivision of the "Interior Region" of the "Eastern Province." The boundaries of this subregion have been variously defined, but they always included the Great Valley of Eastern Tennessee, and more or less of the adjoining parts, chiefly of the Cumberland Plateau. The Cumberland Region in our sense, refers to freshwater life, and includes the *drainages of the Cumberland and Tennessee rivers*

only, from the headwaters down, but leaving out the lowermost sections of the two rivers. It ends, in the Cumberland, about in the vicinity of Clarksville, Montgomery Co., Tenn., for below this point hardly any Cumberlandian shells are known. In the Tennessee, the lower limit of this fauna has not been determined. The Mussel Shoals in Alabama surely possess this fauna, but the whole Tennessee below this point is entirely unknown. Duck River empties into this part of the Tennessee, and, according to my collections, also the lower part of Duck River does not seem to belong any more to the Cumberlandian Region (see below).

Nobody ever has made an attempt to study the Cumberlandian Naiad-fauna, and to single out the forms belonging to it, although attention frequently has been called to the fact, that in this general region a great number of peculiar mussels are found. Thus it will be of interest to know *which species should be regarded as Cumberlandian in the sense here defined.*

It should be noticed that these Cumberlandian shells are not all uniformly distributed over the Cumberland and Tennessee drainages, although there are some which are so. But others are more local. Further, a study of these forms (and of others) brings out the fact, that the Tennessee drainage itself is divided into two sections, that *below Walden Gorge* (below Chattanooga), with its tributaries down to the Mussel Shoals, and that *above this point*, including all the headwaters.†)

Duck River species of general distribution in Cumberland, lower and upper Tennessee: *

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* Also in the Cumberland such a division is evident, namely the part below the falls, and that above. But the latter is rather small and poor in species. Nevertheless, zoögeographically, it surely is interesting, and should receive due consideration in a special study of the Cumberland River fauna.

† In some of the varieties the distribution is not fully known, chiefly in the Cumberland, because their taxonomy has not been studied from the modern viewpoint introduced by myself in my paper on the upper Tennessee shells (Proc. Amer. Philos. Soc. 57., '18). Thus it was necessary sometimes, to unite these forms into groups.

1, 2. *Fusconia barnesian* (two varieties, but only one in Cumberl.; a third not in Duck).
3. *Quadrula intermedia*
4, 5, 6. *Pleurobema oviforme* (three varieties, only one positively in Cumberland).
7. *Alasmidonta minor*
8. *Ptychobranchus subtentum*
9. *Actionaias pectorosa*
10. *Carunculina moesta*
11. *Medionidus conradicus*
12. *Micromya nebulosa*
13. *M. vanuxemensis*
14. *Dysnomia brevidens*
15. *D. lenior*
16. *D. turgidula*
17. *D. florentina walkeri*
18. *D. capsaeformis*

Duck River species found in the lower and upper Tennessee, but not in the Cumberland:

19. *Lexingtonia dolabelloides*
20. *L. dolab. conradi*
21. *Lasmigona holstonia*
22. *Conradilia caelata*

Duck River species found in Cumberland and lower Tennessee, but not in upper Tennessee:

23. *Micromya taeniata*

Duck River species found only in lower Tennessee, but not in Cumberland, and not in upper Tennessee:

24. *Carunculina cylindrella*

Thus 24 species of the Duck River fauna are Cumberlandian types, that is to say, 38% of the fauna.

It should be pointed out, that there are no species in Duck River, which are present only in the Cumberland, but not in the Tennessee, as there seem to be no Cumberlandian species, restricted to the Cumberland alone, i. e. *Cumberland River has no peculiar species of its own!*

These 24 forms enumerated above are not all the Cumberland-types known. There are others, found either in Cumberland and Tennessee, or in Tennessee alone, which have not been found in Duck River. I think it is well to give here a list of them, with short indications of their distribution, so that *we thus get a complete account of what should be called the Cumberlandian Naiad fauna.*

I leave out the group of *Fusconaia pilaris*, because, probably, *pilaris* should not be separated from *subrotunda* of the interior basin.

25. *Fusconala cuncolus* (Lea)—26. *F. cun. appressa* (Lea).—In lower and upper Tennessee, but not in Cumberland, the former in small

streams, the latter in larger ones.

27. *Fusconaia edgariana* (Lea)—28. *F. edg. analoga* (Ortmann).—Like the preceding two forms, the former in the larger, the latter in the smaller streams.

29. *Fusconala barnesiana tumescens* (Lea).—Reported from the Cumberland (as *Pleurobema crudum*). In larger rivers in lower and upper Tennessee.

30. *Quadrula cylindrica strigillata* (Wright).—Headwaters of Powell, Clinch, and Holston only.*)

31. *Pleuthobasus cyphyus compertus* (Frierson).—Local form in the Knoxville region.

32. *Alasmidonta* (*Decurambis*) *raveneliana* (Lea).—Local form in headwaters of French Broad and Pigeon Rivers in North Carolina.

33. *Pegias fabula* (Lea).—In the Cumberland drainage in Rockcastle and Stones River; small streams of lower, and headwaters of upper Tennessee.

34. *Dromus dromas* (Lea).—35. *Dr. dr. caperatus* (Lea).—Cumberland, lower and upper Tennessee, the former in the larger rivers, the latter in the smaller ones; the small-river form has not yet been found in lower Tennessee.

36. *Micromya trabalis* (Conrad).—Metropolis in Cumberland and tributaries. Rare in lower Tennessee (Mussel Shoals and Paint Rock River). In upper Tennessee only in Chickamauga Creek (near Chattanooga) and in Hiwassee River.

37. *Micromya perpurpurea* (Lea).—Only in Clinch, Powell, and Emory Rivers, representing *trabalis*.

38. *Lampsilis virescens* (Lea).—In lower Tennessee, Emory River, and Coal Creek (Clinch drainage) (See: Ortmann, '18 p. 582). Recently an additional locality has been discovered: Emory R., Wartburg, Morgan Co., Tenn.

39. *Dysnomia* (*Truncillopsis*) *araeformis* (Lea.)—Upper Cumberland and lower Tennessee (Mussel Shoals) (rare). Abundant in the Knoxville region of the upper Tennessee.

40. *Dysnomia* (*Scalenilla*) *haysiana* (Lea).—Not rare in Cumberland, lower and upper Tennessee.

41. *Dysnomia* (*Dysnomia*) *stewardsoni* (Lea).—Knoxville region of upper Tennessee.

42. *Dysnomia* (*Dysnomia*) *lewisi* (Walker).—Cumberland River, Burnside, Ky., and Knoxville region of the upper Tennessee.

43. *Dysnomia* (*Pilea*) *torulosa gubernaculum* (Reeve).—Upper Tennessee from the Knoxville region upward.

44. *Dysnomia* (*Pilea*) *biemarginata* (Lea).—Probably large-river-form of *D. turgidula*. Known from Cumberland (Burnside) and the Mussel Shoals in the lower Tennessee. Not in upper Tennessee.

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* I do not believe that it is found elsewhere, as recently reported.

45. *Dysnomia* (*Pilea*) *florentina* (Lea).—The real *florentina* only at Mussel Shoals in the lower Tennessee; reported also from Cumberland River, but this should be confirmed.

Finally there is *Actinonaias carinata gibba* (Simpson) in the Cumberland, lower and upper Tennessee. But this probably is not a typical Cumberlandian form, since it is also found in Green River, Ky., that is to say in the Ohio drainage (I have collected it myself in the vicinity of Mammoth Cave).

This completes the list of "Cumberlandian" Naiades, as far as I am able to make it out. Of the 45 forms enumerated above we may be tolerably sure, that their "center of origin" is in the Cumberland region, or some portion of it, for the reason, that at present they are restricted to it. Twenty-four species out of the 45 are found in Duck River, that is a little over half of them, 53%.

But it is quite probable, that there are other forms, which have their original home in this region; yet they have subsequently dispersed into other parts, chiefly into the Ohio system and the interior basin in general. I shall make no attempt here to single them out, because of the difficulty connected with this task.

No faunistic study is complete, unless it also discusses those forms which possibly might be present, *but have not been found*. It is clear, that it is difficult to positively assert, that a species is missing in a given region, simply because it has not been found: this may be due to accident. But when it concerns widely distributed, well-known, and easily recognizable forms, the argument of them not having been seen, attains greater force. As has been mentioned, the gravel bars of Duck River are thickly covered with dead shells. I made it a point to examine also these dead shells, and several species reported in the above list have been found only in this condition. Yet there are others, familiar to me, which I have never seen. I give here a list of the more important ones, chiefly such as might be expected in Duck River according to its size and general character. All these are species found in the interior basin, and also in the Cumberlandian region. (The Cumber-

landian types missing in the Duck are given above, Nos. 25 to 45).

Cumberlandia monodonta (Say).—Generally a rare form, frequent only in upper Tennessee. This might yet be discovered in the Duck.

Fusconaia subrotunda (Lea), and related forms.—The absence of such forms in Duck River is very striking: I have seen no trace of them.

Fusconaia flava (Rafinesque), and related forms.—Although represented in Cumberland River, and replaced, in the Tennessee by the *cuneolus* and *edgariana*-types, no trace of this group has been seen in the Duck.

Quadrula metanevra (Rafinesque).—A species easily recognized, but not seen by myself.

Plethobasus cooperianus (Green) and *Pl. cyphyus* (Rafinesque).—The genus *Plethobasus* is altogether missing.

Obovaria olivaria (Rafinesque).—Not seen.

Lampsiliis orbiculata (Hildreth).—Not seen; the latter two species are rather rare, at least in the Tennessee.

Dysnomia sulcata (Lea).—An Ohio-form, going into the Cumberland and lower Tennessee (Mussel Shoals). Not seen in Duck.

Dysnomia torulosa (Rafinesque) (probably including *D. propinqua* (Lea).—In the lower Ohio drainage and in the Tennessee, up to the Knoxville region, but not known from Cumberland. Not seen in Duck River.

These forms missing in Duck River, are mostly known to be large-river-forms, some of them also entering smaller streams. Of the Cumberland types, missing in Duck River, (Nos. 25 to 45), again several are large-river-types (*Fusconaia cuneolus appressa, Fusc. edgariana, Fusc. barnesiana tumescens, Dromus dromas, Dysnomia haysiana, Dysn. biemarginata, Dysn. florentina*) while of the Cumberland types *present* in the Duck, the majority distinctly prefers small streams (*Fusconaia barnesiana bigbyensis, Lexingtonia dolabelloides conradi, Pleurobema oviforme argenteum, Lasmigona holstonia, Alasmidonta minor, Ptychobranchus subtentum, Caruculina moesta, Car. cylindrella, Conradilla caelata, Medionidus conradicus, Micromya nebulosa, Micr. taeniata, Micr. vanuxemensis, Dysnomia lenior, Dysn. turgidula, Dysn. florentina walkeri.*)

Typical *small-river-forms of the interior basin,* found in Duck River, are few: *Obovaria subrotunda lens* and *Lampsilis ovata ventricosa* could be named. (*Anodonta grandis* also be-

longs here, but this species is subject, apparently, to peculiar laws of dispersal.)

Thus it is seen, that Duck River has a *mixed fauna, consisting of two elements: a small-river-fauna,* composed largely of *Cumberlandian types* (about 38%), and an element belonging to the *interior basin* (about 62%); the latter consists chiefly of *large-river-types.* This is also shown in the percentage of Cumberlandian types present at the various stations: at Centreville, 0%; at Ben, 11%; at and above Columbia, 31%; Leftwich, 33%; Lillard's Mills, 30%; Wilhoite, 36%; Shelbyville, 41%; Normandy, 86%; Coffee County, 100%; Manchester, 100%; Riverside, 63%; Wartrace, 43% (the latter higher than Shelbyville, the next station below).

It appears that the *Cumberlandian fauna is the original fauna of Duck River,* while the interior-basin-bauna is a later invasion of the river, coming up from the lower parts; yet important elements of the interior fauna have not yet reached Duck River. In the lower Duck, at Centreville, and probably farther down, the interior fauna alone is present, and *this part does not belong to the Cumberlandian region.*

From these facts we may derive the following conclusion. *Duck River originally was more directly connected with the Cumberland and Tennessee, and, at that time, it was a rather small river. Later on, it was brought into closer and more direct connection with the interior basin, probably with the help of the lower Tennessee in western Tennessee and Kentucky,* which, of course, means a *change in the direction of the drainage.* I am not going into the details of this question, chiefly that part of it, which concerns the old connections of Duck River, and the direction of its flow, except that I repeat, what I have just said: *it must have been more closely and directly connected, with both Cumberland and Tennessee.*

At the present time, the *distribution of the Cumberlandian Naiad fauna is markedly discontinuous,* being found in the upper Cumberland, the upper Duck, and the Tennessee above the Mussel Shoals, but *not* in the *lower* Cumberland, the *lower* Duck, and probably also the *lower* Tennessee (downward from some point below the Mussel Shoals, which has not yet been ascertained.)

The present paper has been published with the purpose of furnishing material for the solution of the above question, which is intimately connected with the general problem of the history of the Tennessee-Cumberland systems, and their relation to the adjoining drainages, chiefly also that of the Alabama River. My first contribution toward this aim is the paper on the upper Tennessee shells, frequently referred to above, and additional material will be found in the series of papers on Naiades from the Gulf drainage, published recently in the "Nautilus" (Naut. 35. '23 p. 73 ff., p. 129 ff., and 37, '23 p. 56 ff.).

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